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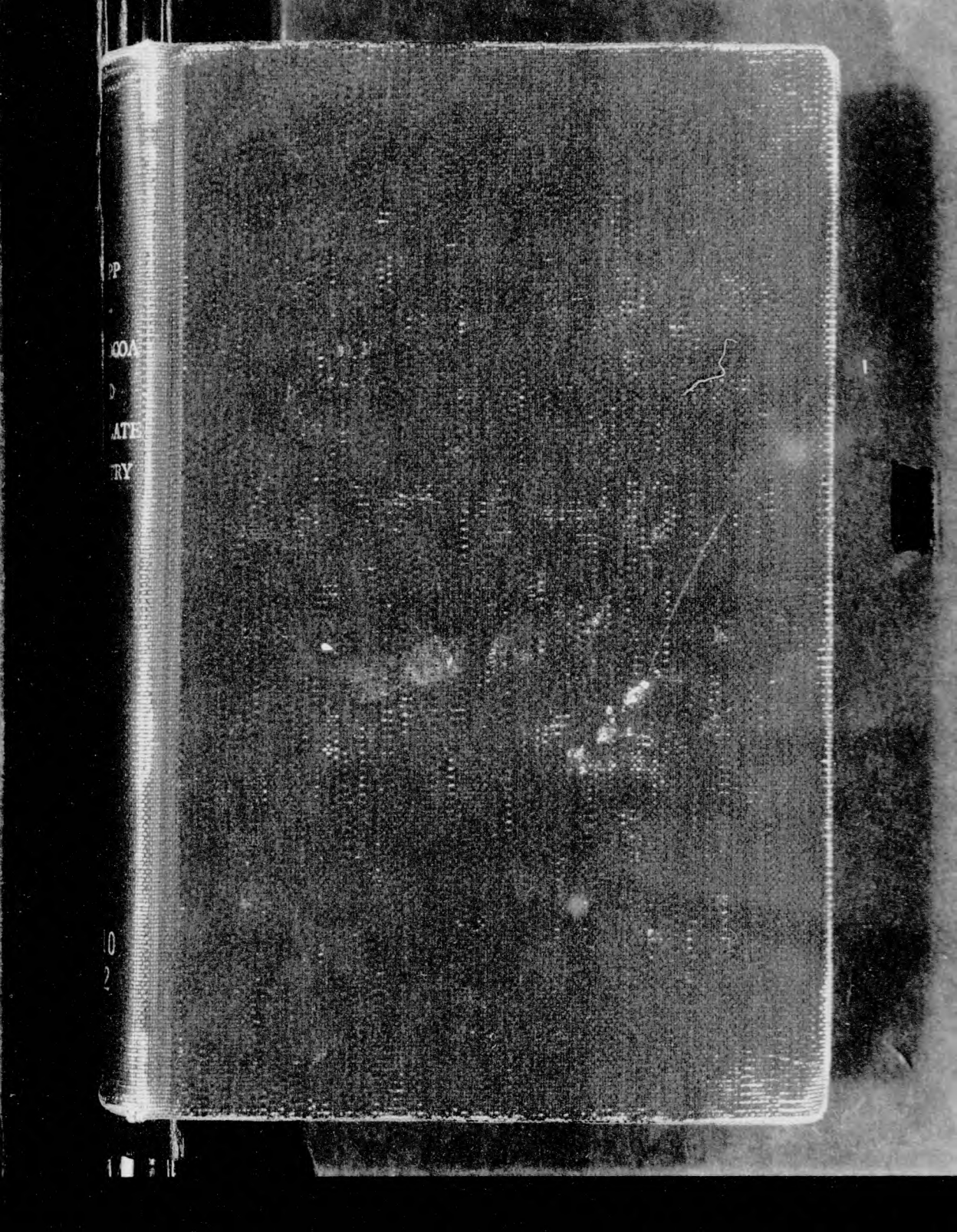

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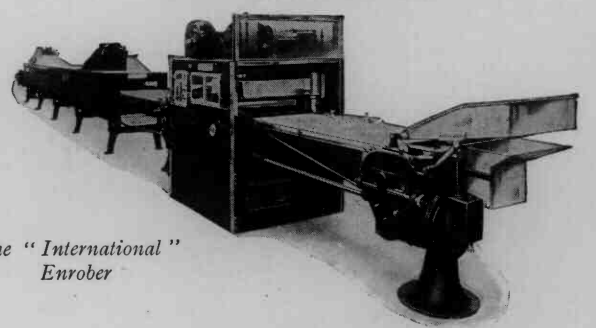

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THE COCOA AND CHOCOLATE INDUSTRY

THE TREE; THE BEAN; THE BEVERAGE

BY
ARTHUR W. KNAPP
M.Sc., F.I.C.

SECOND EDITION
REVISED AND ENLARGED

LONDON
SIR ISAAC PITMAN & SONS, LTD.
PARKER STREET, KINGSWAY, W.C.2
BATH, MELBOURNE, TORONTO, NEW YORK
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TO
MY BROTHER

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GOLD COAST GIRL CARRYING CACAO PODS

Frontispiece

Feb 4, 1931 DA/HEC

PREFACE TO SECOND EDITION

THE kindly welcome which the first edition received, and the fact that no single book covering the whole industry has appeared in the intervening years, has encouraged me to bring the old material up to date and to add new. I have endeavoured to keep the book sufficiently free from technicalities to be appreciated by the non-technical reader. At the same time I have peppered it with enough facts to make it useful when read as a miniature work of reference.

In revising I have made several cuts, but I have not shortened the long chapter on the history of cacao, as I consider the history forms the best introduction to the subject. I have strengthened the part dealing with manufacture by the addition of a considerable amount of new material, including chapters on food value, on adulteration and definitions, and on storage. Of these the last should prove of particular interest to shopkeepers and wholesale dealers.

I am indebted to various people for the new illustrations. Messrs. Cadbury Bros. have lent me the blocks for the new coloured frontispiece and for a number of other illustrations. The illustration on page 11 is taken by permission from a photo of Criollo pods growing in Venezuela on the estates of Messrs. Joseph Terry & Sons. The diagrams of machinery on pages 122, 137, 141, and 144 are taken from an earlier book of mine on *Cocoa and Chocolate*, by permission of the publishers, Messrs. Chapman & Hall. The diagram

showing food values I owe to the Cocoa and Chocolate Research Association; and the reproduction on page 65 is from a photo of part of one of the new dioramas at the Imperial Institute, London. Everyone who is interested in cacao should see these beautiful and instructive dioramas which, with the exhibits of cacao pods, etc., would help the reader to visualize more completely the industry described in this book.

A. W. KNAPP.

BIRMINGHAM

PREFACE TO FIRST EDITION

WHILE there are several masterly treatises, mainly scientific, on the various natural divisions of the cocoa and chocolate industry, there is no low-priced primer dealing with the whole subject. I have aimed at producing such an introductory handbook and have attempted to present in readable form the mass of historic, scientific, and economic facts necessary for a general appreciation of the industry as it exists to-day.

While the general reader may skip the chapter dealing with the cost of production as being too arithmetical, those who are in any way connected with cacao planting will find it the most provocative chapter in the book. I owe the data for this chapter tc two experienced planters, Mr. E. W. Keith of Ceylon, and Mr. Stanhope Lovell of Trinidad.

The frontispiece I owe to the kindness of Mr. S. H. Davies—it is from a photo by Adhar, of San Fernando, Trinidad. I wish to thank Messrs. Fry & Sons, Ltd., Messrs. Rowntree & Co., Ltd., and Messrs. Cadbury Bros., Ltd., for allowing me to reproduce photos showing machinery in their factories. To the last named I am also indebted for a number of photos showing cacao cultivation. I acknowledge with pleasure the help received from several of my colleagues, in particular Mr. W. Pickard, Mr. E. J. Organ, and Mr. A. B. Hall. I thank Mr. W. E. Cossons for reading the proofs.

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THE COCOA AND CHOCOLATE INDUSTRY

CHAPTER I

INTRODUCTORY

Cocoa and chocolate do not appear to be important articles of commerce until one remembers that every grocer sells cocoa, and that the principal sweetmeat in the multitude of confectioners' shops is chocolate. The magnitude of the trade is perhaps better realized when one is reminded that the cultivation of cacao is the chief industry in several of our colonies, and that a single firm, manufacturing cocoa and chocolate in the Midlands, employs 9,000 people. It is proposed in this little handbook to describe briefly the various stages in this industry, from the cultivation of the raw material to the sale of the finished product, or—to use a slick phrase after the manner of an American advertisement—to sketch the career of cacao from the pod to the palate. A short description of the cacao tree will be given for the benefit of those readers who approach the subject for the first time. This will be followed by a chapter dealing historically with the main events in the development of the cultivation of cacao, and the manufacture of its products. The remainder of the book will describe in logical sequence, as far as possible, how the cacao bean is produced and prepared for the market at the present time, and the various processes through which it passes before it becomes the cocoa and chocolate of commerce. The cultivation of cacao, like the manufacture of chocolate, is partly a science and partly an art. It affords

numerous examples of the importance of commercial considerations. While these, unlike the scientific and artistic aspects, make little or no appeal to the finer instincts, they determine whether or not an industry shall exist, and when they can be sublimated into economics, become an interesting intellectual study.

It is advisable at once to explain the difference between " cacao " and " cocoa." The correct name of the raw product is cacao; thus the French, Dutch, and Spanish call it " cacao," the Italians " caccao." and the Germans " kakao." Only the English, as the outcome either of laziness or the confusion that came from the careless spelling, so characteristic of the early days when cacao was introduced, call it " cocoa." Whether our English ancestors thought cocoa came from the coconut (or cocoanut, as some incorrectly write it, Dr. Johnson having given currency to this error in his dictionary), or whether they found the original Mexican word too difficult to pronounce, is undecided, but the mis-spelling of these words continues to confuse the " man in the street " to this day. In the case of " cocoa butter," as it is spelled in market reports, even amongst business men and manufacturers confusion has arisen between the butter obtained from cacao beans and that from coconuts, so that scientists and technicians have determined to call the product from cacao beans " cacao butter," and that from the milky coconut " coconut oil." Even though a name has been accepted for over 200 years, it is better that it should be discarded than that it should cause confusion. In this book the writer proposes to retain the word " cocoa " only for the finished product, the cocoa-powder which one purchases in grocers' shops. " Cacao " will be used to indicate the raw material, cacao seeds or beans; it will also be used as a descriptive adjective for the tree, the butter and the shell. In this way we may reap an advantage from the seed of error, because

the use of the two spellings will prevent any possible confusion between the raw material and the finished product. The whole of the scientific world is with the writer on this question of spelling, but the world of trade is as conservative about names as it is about weights and measures, and slow to change without obvious monetary advantage. The manufacturer's representative says convincingly to the grocer, " I am sure this cocoa will please your customers," when referring to *cocoa* powder; the broker says, " Cocoa is up to-day," meaning that *cacao* beans are higher in price; and the planter very genially says, " Let us go into the cocoa," when he wants you to see the *cacao* (not the coconut) plantation. There is little reason for the broker or planter to change the word; they may even be excused a little irritation at what they probably regard as an unnecessary alteration. In this book the more scientific spelling is adopted, not from pedantry, but because the writer wishes to avoid the possibility of confusing any seeker after knowledge.

CHAPTER II

DESCRIPTION OF THE CACAO TREE, ITS FLOWERS AND FRUIT

THE cacao plantation might be described as a tropical orchard. It resembles an orchard in that it contains trees, planted at more or less regular intervals, of about 15 ft. to 25 ft. in height, that is about as tall as, or a little taller than, our fruit trees. The resemblance does not go much further; here and there in the cacao plantation a huge tree towers above the cacao trees, as one may imagine oaks towering above the apple trees. The reason for having these giant trees will be explained later when cultivation is discussed. If one thinks of an English orchard one may picture the black straggling branches against a November sky, or the brief pink and white glory of the blossoming boughs in the spring sunlight, or the ripe fruit hanging in the leafy tree on a summer's day. The cacao plantation is in all seasons like an orchard in summer time, in that all the year round the fruit may be seen hanging on the tree, the branches of which are thickly covered with dark-green leaves. The leaves are sufficiently large and numerous to act as an almost perfect screen to the fierce tropical sun, and one steps with grateful feelings from the too brilliant sunshine outside to the cool shade under the cacao trees. The winter aspect of English orchards is never seen with cacao trees, save when they have been denuded by the wind, and then they soon become covered with young flaccid leaves through which the light shows red. A curious feature of the cacao leaf is the double articulation at either end of the stalk, which forms a universal joint, and makes it possible for the leaf to rotate in any direction, so that the upper surface always faces the light. At no time

do cacao flowers make a brave show like our apple blossom; they are very small and frail, and, like most tropical flowers, have no scent. The eye has to seek for cacao-flowers, but when found, one admires them for their pale-pink and yellow colour and delicate form. They grow in tufts or clusters and have five yellow petals on a rose-coloured calyx. To the astonishment of the visitor from England, these flowers do not grow near the ends of the twigs, but spring only from the trunk and main branches of the tree. The flowers usually grow from a cushion or boss in the bark, and may sometimes be found on the trunk not a foot from the ground. One's ignorance might be excused if one mistook them for a novel kind of club moss.

A full-grown tree will bear in one year over 6,000 flowers, but of these only 10 to 60 will become mature fruit! Until 1925 little was known of the floral biology of cacao. The method of fertilization of the flowers has long been subject to discussion as the shape of the flower does not appear to admit of self-pollination, although Dr. von Faber believed he had proved by his experiments in Java that self-pollination was the rule. Professor Harland has shown that under Trinidad conditions 35 per cent of the flowers attended by ants and aphides are efficiently pollinated. One concludes that these insects are responsible for a considerable amount of pollination. As pollination is the first step towards a good yield of cacao, the writer ventured in the first edition of this book to suggest that as self-pollination is difficult, the planter should pollinate the flowers with a brush and thereby materially increase the yield. In the case of palm fruit, artificial pollination promises to revolutionize the industry —it is now carried out over thousands of acres and has led to an increased yield of 100 per cent. Dr. Stahel, working on cacao in Surinam, has succeeded, by artificial pollination, in making 80 per cent of the flowers

produce fruits. However, Professor Harland's experiments show that lack of pollination is not the main cause of a poor crop, but rather the failure of the fruit to set. On certain trees—unproductive trees, several hundred flowers were pollinated without a single pod being set; but on other trees—good bearing trees, a large number of pods could be set at any time by hand pollination. It is clear from the practical point of view that the elimination of the poor "setters," and the breeding out of a strain of high-setting capacity, would be a very valuable piece of work. The question of yield is vital to the whole industry, and whilst it would be unreasonable to expect 80 per cent of the 6,000 flowers to become pods, it is reasonable to hope that the present average annual yield of about 20 pods per tree will, in the not too distant future, be improved upon.

Flowers, small fruit (resembling gherkins), and mature fruit are to be seen growing side by side on the same tree, practically all the year round. In West Africa the flowers are most numerous from April to June, and, as the time taken from the opening of the flower to the production of the mature fruit is twenty-three weeks, the greatest quantity of ripe fruit is gathered from October to December, when people in England are shivering by their fires.

The mature fruit is a pod about 6 to 8 in. long, and weighs from 10 to 20 oz. The shape and size vary according to the botanic species and variety. The colours of the pods are remarkable for their richness. When unripe they may be as green as grass, and when mature golden-yellow, or maroon, or crimson tinged with purple. Ever since the tree was christened by the great Swedish scientist, Linnæus, it has been known to botanists as *Theobroma cacao* (Greek, *theos*, a god; *broma*, food). Lovers of cocoa and chocolate will consider it poetic justice that this tree should be called

the "food of the gods." Botanically it is classified thus: *FAMILY:* Sterculiaceæ. *GENUS:* Theobroma. *SPECIES:* *Theobroma cacao*, *Theobroma pentagona*,

FIG. 2. CACAO TREE WITH A GOOD CROP OF PODS

Theobroma sphaerocarpa. The family of the Sterculiaceæ is related to the mallows and the linden tree. There are only two important genera: the cacao tree and the kola-nut tree, the fruits of which very much resemble one another externally. There are, perhaps, a score of species of Theobroma, but the only ones of

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produce fruits. However, Professor Harland's experiments show that lack of pollination is not the main cause of a poor crop, but rather the failure of the fruit to set. On certain trees—unproductive trees, several hundred flowers were pollinated without a single pod being set; but on other trees—good bearing trees, a large number of pods could be set at any time by hand pollination. It is clear from the practical point of view that the elimination of the poor "setters," and the breeding out of a strain of high-setting capacity, would be a very valuable piece of work. The question of yield is vital to the whole industry, and whilst it would be unreasonable to expect 80 per cent of the 6,000 flowers to become pods, it is reasonable to hope that the present average annual yield of about 20 pods per tree will, in the not too distant future, be improved upon.

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Fig. 2. Cacao Tree with a Good Crop of Pods

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commercial importance are Theobroma cacao, Theobroma pentagona, and Theobroma sphaerocarpa, and of these, Theobroma cacao produces at least nine-tenths of the world's cacao.

There are two principal varieties of Theobroma cacao, called *Criollo* and *Forastero*. These names have been wrested from their original meaning, which was "Creole" and "foreign," implying respectively, that one kind of cacao was native, and the other imported from a foreign country. The use of these names in this sense could only lead to confusion, and botanists have agreed to classify the trees according to the character of the pods and the seeds they contain. The pods of Theobroma cacao show small but appreciable variations as one passes from country to country, and out of this chaos the botanist attempts to make order by noting the more fundamental resemblances and differences. Of the various classifications, the simplest is that mentioned above. In this, Theobroma cacao is divided into two main varieties, Criollo and Forastero, and then into local types and sub-varieties The table below, after Van Hall, illustrates this—

THEOBROMA CACAO

Criollo	Forastero
Local Types	*Sub-varieties*
Venezuela Criollo	Angoleta (Trinidad Forastero)
Ceylon Criollo	Cundeamor (bottle-necked, so-called Trinidad Criollo)
Java Criollo	Amelonado (melon-shaped)
Samoa Criollo	Calabacillo (round and smooth)
Madagascar Criollo	
Nicaragua Criollo	

Criollo. The pods of this variety are as embossed as a crocodile's back or the bark of an ancient oak. The shape is somewhat like an elongated lemon, only that it is broad at the point where the stalk is attached and tapers at the other end. The wall of the pod has ten longitudinal furrows, five of which are very marked; it is soft and can easily be cut with a knife. (See Fig. 4.)

Forastero. This variety has less warty pods than the Criollo, and the walls are more woody in character. The shape of the pod varies considerably; one kind, *Angoleta*, resembles Criollo; another, *Cundeamor*, is bottle-necked; another, *Amelonado*, resembles a melon; and a fourth kind, *Calabacillo*, is as globular as a calabash. In a single Trinidad plantation one may find not only all these kinds, but all manner of intermediate and indeterminate types. It is interesting, with the above differences in mind, to walk through a plantation and attempt to name the varieties. One can best determine whether one has been successful by taking a pod from the tree and cutting it open. The more easily one cuts open the pod, the more sure one is that it is Criollo, but it is the colour of the seeds inside which enables one to make a final decision. On opening the pod there is a pleasant odour resembling melon. The inside of the pod, like a young chestnut burr or the pod of a broad bean, is lined with white pulp. Inside there are 20 to 40 seeds packed closely together. These seeds are also thinly covered with a glistening snow-white or pale-heliotrope pulp, so that they slip through the fingers with the same facility as the seeds of a melon or cucumber. On putting one of the seeds in the mouth the pulp is found to be sweet and faintly acid. On biting through the seed one finds that it is bitter and astringent, particularly if it is the Forastero variety, and one spits it out as not being sufficiently pleasant to eat. This discovery strikes one as curious, since from these same seeds are prepared those delightful foodstuffs, cocoa and chocolate. When prepared for the market the cacao seeds are always known incorrectly as beans. On examining the seeds after the pulp has been removed, one finds that in the Criollo variety the seeds are large, plump, and in colour white, or almost white; whilst the Forastero beans are smaller, flatter, and heliotrope in colour (the Calabacillo sub-variety

being the smallest and most deeply coloured). There are Forastero trees which give pods containing both white and purple beans, for example, the ordinary Forastero in Ceylon gives about 37 per cent white and 63 per cent purple. The simplest and most satisfactory classification for commercial purposes is by means of

FIG. 3. CACAO TREE, SHOWING PODS AND FLOWERS

the colour of the seeds. If they are white they are Criollo, and if they are heliotrope or purple they are Forastero.

Yield. The weight of pulp-covered seeds from a pod varies naturally with the size of the pod, the type of cacao and the amount of pulp; it may be taken as being roughly one-quarter of the weight of the pod. Thus a pod weighing 1 lb. contains on the average about 4 oz. of pulp-covered seeds which would yield

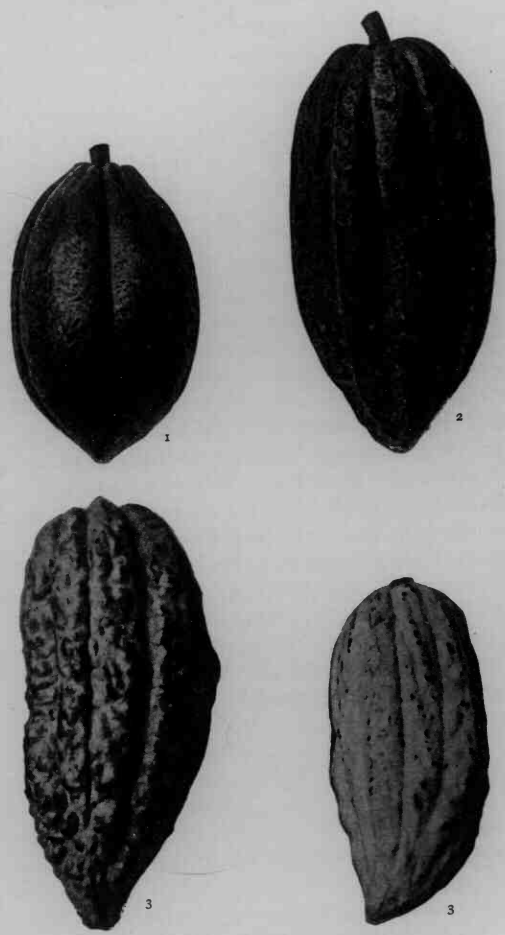

FIG. 4. VARIETIES OF CACAO PODS

1. *Forastero Amelonado*—the typical West African variety
2. *Forastero Veraguso*—a well-known Trinidad variety
3. *Criollo* pods from Venezuela

INTENTIONAL SECOND EXPOSURE

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about 1½ oz. of the dry, cured cacao beans of commerce. This impresses one as a small amount, but the weight of cacao yielded by the tree is even more surprising. In the new world (Brazil, Ecuador, or the West Indies), a very good yield is 5 cwt. of cacao beans to the acre. If the acre contains 280 or more trees, this is equivalent to 2 lb. or less from each tree. In C. Y. Shephard's economic survey of the cacao industry of Trinidad in 1927, he states that it is probable that the average production on all Trinidad estates is not much in excess of 825 lb. per 1,000 trees. This is equivalent to about 2 cwt. to the acre, or under 1 lb. to the tree. These facts may well stagger the economist and cause the would-be planter to pause. On the native farms of the Gold Coast the trees are much more productive, and H. A. Dade states that the average yield (in the Anyinam district) for 1926 was as high as 11 cwt. per acre. With the exceptional yields on the Gold Coast included, it is doubtful if the average yield of all the cacao trees in the world exceeds 2 lb. to the tree per annum. The reader will wonder how the planter makes the cultivation of cacao pay, and may inquire how vast a multitude of people are employed to look after the 500,000,000 cacao trees required to produce the crop. An attempt will be made to answer these questions in a later chapter.

CHAPTER III

OUTLINE OF THE HISTORY OF COCOA AND CHOCOLATE

1. BEFORE A.D. 1500

The Origin of Cacao Cultivation and Chocolate Preparation

THE early history of cacao is lost in antiquity. If we may believe the Mexican mythology (much virtue in an if), chocolate was consumed by the Gods in Paradise, and the seed of cacao was conveyed to man as a special blessing by the God of the Air. The problem of discovering the original home of the cacao tree is generally admitted by botanists to be beset with well-nigh insuperable difficulties. Various writers state that they have seen cacao growing wild in Central America, in Martinique, in Trinidad, and in Guiana, but the evidence that these trees were not descended from cultivated trees is considered inconclusive. On the whole, Von Humboldt's belief that cacao was indigenous to the forests of the Amazon and Orinoco remains to this day the most acceptable theory. From this region it was probably taken by wandering tribes to other parts of tropical America. Thus it is well known that the Aztecs of Mexico and the Incas of Peru cultivated cacao. Cortes, that brave but callous conquistador, made in 1519 the discovery that cacao was widely cultivated in Mexico, and the drink prepared from it consumed in large quantities by Mexico's ruler, Montezuma, and his court. Such was the knowledge of both cultivation and preparation displayed by the Aztecs, that one can only conclude it had already been grown by them for many generations.

De Candolle, in his *Origin of Cultivated Plants*, asserts

that the cacao tree has been cultivated in America for 3,000 or 4,000 years—a prodigious period, hard to conceive. Certain it is that many chieftains of Mexico, either Toltecs or Aztecs, must have consumed chocolate before Montezuma indulged his fancy for this delicacy, but, until Columbus discovered the great continent of America, Europe knew nothing of the Western hemisphere and no European had ever seen a cacao bean. The Aztecs, besides their vast palaces and ingenious forts, possessed other evidences of a civilization equal, if not superior, to that of Europe. In spite of these, and of the fact that they had elaborated independently the art of picture-writing, their early history is a mere "distillation of rumour." There is evidence that they conquered the more peaceful Toltecs, and first reached the City of Mexico in 1324. How and when they acquired their knowledge of cacao are open questions.

Where history is vague and indefinite, the imagination elaborates its own forms when the mind peers with eager eyes into the dark caverns of the past. It is probable that in ancient times, long before the Britons had learned to daub their bodies with woad, an early Aztec or possibly a Toltec, who was in the habit of quenching his thirst by sucking the juicy pulp of the seeds in the cacao pod,[1] accidentally threw some into a fire. Soon he became conscious of scented odours and a spicy air, and, having found their origin, tasted for the first time the roasted bean. One can but admire his dietetic courage. His statue should stand beside those of the men who first consumed a mushroom, a tea leaf, and a coffee berry. Often by accident, when he was sucking the raw seeds of cacao, his teeth must have bitten through the pulp into the interior, and

1 "We met with no tribe on the Orinoco that prepared a beverage from the seeds of the cacao tree. The savages suck the pulp of the pod and throw away the seeds." Von Humboldt's *Travels in America* (1799–1804).

his palate have perceived an unpleasant bitter flavour. Now, however, he would find that the roasted seed, although still bitter, had acquired a very attractive aroma and taste. After that experience he would be always flinging cacao seeds into the fire, and little by little would learn to roast them to just the right degree to suit his taste. Later, a man of more delicate digestion would grind the beans and the beginnings of the manufacture of chocolate would be established.

2. THE SIXTEENTH CENTURY

The Spanish gain Knowledge of Cacao and Chocolate from the Mexicans

Of the three national beverages (tea, coffee, and cocoa), the raw product, the cacao bean, had the honour to reach Europe a century before the tea leaf or coffee berry. Columbus not only discovered America, he also discovered the cacao bean and brought a few home to Spain with him as curios from the new world. What remark King Ferdinand made when he saw these brown beans, which somewhat resemble almonds in appearance, is not recorded. Possibly it was not very complimentary. It was the adventure of another Spaniard, Cortes, that revealed the probable commercial importance of these strange seeds. It has already been mentioned that Cortes, in his ruthless conquest of Mexico (1521), encountered the Emperor Montezuma, who entertained him royally. This contemporary of Henry VIII, this chieftain styled emperor by his conquerors, is worth more than a passing reference because of the important part which the drinking of chocolate played in his feasts. Montezuma was "haughty and fiery proud," with tastes as magnificent as his pride, and his imperial sway was like that of an Oriental despot, both in severity and splendour. Prescott, in

his classic work on *The Conquest of Mexico*, states that " the emperor took no other beverage than the *chocolatl*, a potation of chocolate, flavoured with vanilla and other spices, and so prepared as to be reduced to a froth of the consistency of honey, which gradually dissolved in the mouth and was taken cold." At one banquet they brought in fifty great jars and drank it from golden goblets, while 2,000 jars were served to the guards and attendants. So writes Bernal Diaz del Castillo, who was present at the feast. And reading between the lines one knows that the Spaniards, despite their arrogance, were impressed. Whether they enjoyed this amazing beverage is another matter, for one must remember that it contained no sugar. The Aztecs had never seen a sugar-cane, although the Spaniards knew it well, having a few years before introduced it into the West Indies.

The Mexicans used cacao beans, as others use cowrie shells to-day, as a medium of exchange. The lords of Mexico paid tribute to their emperor in cacao beans. It is not easy to fix the value of this currency. One reads that a tolerably good slave could be obtained for 100 beans, so either slaves were cheap or cacao dear. A more exact idea of their value can be obtained from the statement of Thomas Cavendish (1586) to the effect that 150 beans were exchangeable for a Real of Plate (about 6d.). This would make the cacao worth about 1s. 4d. a pound. Considering the purchasing power of a penny in the sixteenth century, one can agree that those who drank chocolate then were, both literally and metaphorically, drinking money.

The Spaniards with Cortes, and others who came later, scented profit. They noted how the tree was cultivated, and watched how this drink, this *chocolatl*, as the Mexicans called it, was prepared. The Spaniards were thus the first Europeans to gain knowledge of this remarkable drink, which was at once both

substantial belly-timber and kick-shaw. Quick to appreciate its commercial possibilities, they planted cacao in other of their foreign possessions. With all the finesse of their race they kept the methods of cultivation and preparation a secret for nearly 100 years, so that though popular in Spain it was practically unknown in other countries until the next century. Those who sing the delights of Elizabethan England should remember that it lacked many priceless things, for example, tea, the solace of old maids; coffee that " makes the politicians wise "; the prosaic potato, the housewife's stand-by; and, above all, man's most useful weed, tobacco, and woman's most luxurious necessity, chocolate. Cacao was, however, mentioned in one or two places, namely, in MS. in the British Museum entitled *A Voyage to the West Indies and New Spain (Yucatan) made by John Chilton in the year* 1560, and in the book by Bernal Diaz del Castillo on the Conquest of Mexico (1568). In a treatise by Clusius (Charles l' Écluse?) on *Plantae exoticae* (1582) cacao seeds were figured for the first time.

The earliest illustration of the cacao tree occurs in a book entitled *The History of the New World*, which was originally published in Venice in 1565. In this book, the author, Girolamo Benzoni, describes his adventures in tropical America. He mentions that Nicaragua contains an incredible number of parrots, and also two things not found elsewhere in the Indies " save in Guatimala, Cape Fonduri (Honduras) and Mexico and along the shores of New Spain "; a peacock and " cacauate."[1] No one seems to have pointed out that the word in the text of Benzoni's book " cacauate " is almost certainly a printer's error. What Benzoni wrote was probably *cacauatl*, which the reader will note the draughtsman has incorrectly written as

[1] " Cacauate " is incorrectly spelled " cacavate " in some translations.

cacauaté. Whether this be true or not, *cacauatl* was the Mexican name for the cacao tree, and all nations derive their words for cacao from this source. Benzoni observed the use of larger trees to shelter and shade the cacao tree. He states that they doubled down the head of the larger tree to accomplish this, as is shown

FIG. 5. OLD ILLUSTRATION OF CACAO TREE AND SHADE TREE
(From Benzoni's *History of the New World*, 1565)

in the illustration. This seems incredible, yet Benzoni was an honest man and a careful observer.

The method of preparing the drink was naturally primitive. The beans were dried in the sun, and then roasted in an earthen pot. The shells of the beans were then removed and the beans ground in the following manner: the cacao was placed on a flat or concave stone, and another stone, shaped like a rolling pin, was rubbed to and fro upon it. The Mexicans used the

same kind of stone for grinding maize.[1] The liquid or paste so obtained, mixed with spices, was kneaded into cakes with the hands and allowed to solidify. A piece of one of these cakes was triturated and mixed into a froth with water with a special stirrer or whisk, a kind of combined grinder and swizzle stick, called a *molinet*. This was presumably a Mexican invention, as it is always exhibited in the old pictures of Mexicans. Honest old Benzoni says that at first, much to the natives' amusement, he refused to taste this drink considering it " more suitable for pigs than for men." " But," he adds, " subsequently, wine failing, and unwilling to drink nothing but water, I did as others did. The flavour is somewhat bitter, but it satisfies and refreshes the body without intoxicating. The Indians esteem it above everything, wherever they are accustomed to it."

The Indians (as Columbus called the natives of tropical America, thinking it was another part of India) were the first to esteem chocolate, and then the Spanish began to value it highly. It will be explained how, in the next century the rest of Europe followed suit. In engravings in old books the Mexican Indian always stands for chocolate, just as the Chinaman stands for tea and the Arabian for coffee. The association of the Aztecs with chocolate will remain for all time, though curiously enough no manufacturer appears yet to have used the name *Aztec* to designate a brand of chocolate.

3. THE SEVENTEENTH CENTURY

Chocolate becomes a Fashionable Drink

With the decline of the power of Spain the methods of making drinking chocolate gradually leaked out, and the information was spread all over Europe, not only

[1] Hence possibly the curious error in Van Hall's well-known book on *Cacao*, in which the reproduction of the illustration from Benzoni's book, showing the method of making bread from maize, is entitled " Indians roasting and kneading cocoa."

by travellers and monks, but also in learned treatises on the subject. Hitherto, as we have seen, the references to chocolate had been casual and scattered, but now, for the first time, works devoted entirely to chocolate began to appear. The first of these, entitled *Del Chocolate*, by Cardenas appeared in 1609, and, being published in Mexico, passed almost unnoticed. In 1631, there was published in Madrid a book on chocolate which became the standard work of the century. Its author was Colmenero, and the title of the book when translated into English was *A Curious Treatise of the Nature and Quality of Chocolate*. It was translated into many languages and passed through several editions.[1] The following recipe taken from this book gives one an idea of the character of the beverage prepared from the cacao bean in the seventeenth century—

> Take a hundred cacao kernels (that is about a quarter of a pound), two heads of Chili or long peppers, a handful of anise or orjevala, and two of mesachusil or vanilla—or instead, six Alexandria roses, powdered—two drachms of cinnamon, a dozen almonds, and as many hazel-nuts, a half-pound of white sugar, and annotto enough to colour it, and you have the king of chocolates.

From an English edition we learn that the new drink, chocolate, was taken frequently at Oxford in 1650, that is a year after King Charles was beheaded. The first cocoa house was advertised in 1657, and was to be found in Bishopsgate Street in Queen's Head Alley. Other houses, both in London and Amsterdam, were soon opened, and chocolate became and remained a fashionable drink, the different chocolate houses and

[1] It was translated into English by Don Diego de Vades-Forte (J. Wadsworth) in 1640, into French by René Moreau in 1643, into Latin by J. G. Volckamer in 1644, into Italian by A. Vitrioli in 1667. Then came Sylvestre Dufour, who gave it new life by publishing it in 1671 along with treatises on coffee and tea. This compilation was so popular that it was revised and published again in 1685, 1688, and 1693. In 1685 it was translated into Latin by J. Spon and into English by J. Chamberlaine.

clubs being the resorts of characteristic sections of the *élite*. This was about the time that the frequenting of coffee houses was passing from the fashionable to the populace, and the elegant and refined began to forgather at the chocolate houses. After the Restoration the price of chocolate was about 10s. to 15s. a pound. As chocolate was new, costly, and delicious. one can understand that it added to the self-satisfaction, already exquisite, of those who sipped it.

The seventeenth century saw cocoa pass triumphantly through the war of wit that all new things must encounter. Those who knew a little praised it as a poet sings of his love, and those who knew less condemned it lavishly out of the wealth of their ignorance. According to some writers one could live fully on chocolate alone; it quenched the thirst and allayed fevers; it was the milk of old men, and was a hive of secret virtues. On the other hand, Joseph Acosta in his *Historie of the East and West Indies*, 1604, wrote: "the chief use of this cocoa is in a drincke which they call chocolaté, whereof they make great account, foolishly and without reason; for it is loathsome to such as are not acquainted with it, having a skumme or frothe that is very unpleasant to taste, if they be not well conceited thereof."

Some writers passed from depreciation to denunciation. Thus Joan Franc Rauch, in 1624, published in Vienna a treatise condemning chocolate as a violent inflamer of the passions, and asking that the monks should be forbidden to drink it. Another writer complained that the very addition which had made chocolate popular, namely sugar, had destroyed its value, because sugar was a corrosive salt and a hypocritical enemy of the body. In spite of these diatribes, from being drunk chiefly by wealthy epicures and cranks, mainly as physic, chocolate became widely appreciated, and by the end of the century its cost and rich nature

alone prevented it from becoming universally popular. It should be noted that the original Mexican beverage was a coarse mixture, generally containing no sugar and often flavoured with hot spices, and that it was served cool or as cool as the tropical climate permitted. Such a drink could never have found favour in Europe. Served hot, with a generous helping of sugar, everyone agreed with Mr. Samuel Pepys that " jocolatte " was " very good."

Many of the chocolate houses in later days became famous as clubs. Most readers will have heard of White's Chocolate House, adjoining St. James's Palace, and of the " Cocoa Tree " Club, 64 St. James's Street, Piccadilly.

Although the use of chocolate spread over Europe, Spain retained her hold on the trade. The whole of the raw cacao was obtained through Spain from tropical America until toward the end of the seventeenth century. It seems probable that the English chocolate houses purchased their chocolate ready-made, from Spain or France. That the greater part was imported as chocolate is indicated by the fact that the first duties were imposed not on the importation of raw cacao, but on the sale of the finished product. Thus in 1660 Parliament granted to Charles II a duty of 8d. on every gallon of chocolate made and sold, and in the reign of William and Mary (1690) a law forbade the sale of drinking chocolate without a licence. Although no doubt here and there individuals ground their own cacao beans, it was not until the next century that the manufacture of chocolate was the general rule in Britain.

4. THE EIGHTEENTH CENTURY

The Passing of Preparation by Hand

During this century chocolate began to be made and sold in little shops in many towns in England, and in

one instance at least the shop developed into a small factory using a steam engine to drive its grinding mills. It would be interesting to attempt to trace what were the factors which determined that, of many small makers, Fry & Sons in England (founded 1728) and Walter Baker & Co. in America (founded 1780), should survive and flourish continuously right down to the present day. They resemble one another in that they were both founded by doctors, and in that they were the first chocolate makers in their respective countries to establish mills run by water-power. The doctors of those days were generally apothecaries, and hence were naturally fitted to become chocolate makers. They were experienced in the use of mortar and pestle for grinding, had knowledge of flavourings and spices, and were generally adepts in the art of mixing confections, for a confection originally was an unpleasant medicine made palatable by the use of sugar and aromatic substances. When Dr. Joseph Fry began to make chocolate in 1728, having secured a valuable patent from Walter Churchman, the whole of the work was done by manual labour. A chocolate factory was built at Steinhunde by Prince Wilhelm von der Lippe in 1765, and the firm of Lombart, " la plus ancienne chocolaterie de France," was founded in 1760, but apparently, in both of these factories, the whole of the chocolate-making was done by hand. Cacao beans are by no means easy to grind, and the introduction of water power to drive the mill must have been a great step forward. Messrs. Fry had their famous " water engine " at Castle Mills, Bristol, and Dr. James Baker had his on the Neponset River, U.S.A. By about 1770 Watt had perfected his steam engine, and in 1795 Messrs. Fry made a further step towards mass production by erecting one of these powerful engines, the first in Bristol, for what the chroniclers of the time described as the " trifling object of grinding chocolate."

The price of chocolate was lowered during this century; for example, that produced by Walter Churchman's patented process in 1730 could be sold, the plain kind at 5s. a lb., and that with vanilla at 6s. a lb. High excise duties continued to hamper the trade. In the *Humble Memorial of Joseph Fry*, 1776, he states that not only do cacao beans pay 10s. per cwt. duty, but the chocolate obtained from them pays 2s. 3d. a lb. He adds that "smuggling is vastly increased in Bristol by a desperate Gang of Villains," and that the smuggled chocolate was daily hawked about the streets of Bristol, Bath, Salisbury, Worcester, and Birmingham. With such high duties levied upon it, chocolate could not be sold at a price low enough to suit the incomes of the mass of the people, and it is not surprising to find that the total quantity of raw cacao imported into Great Britain by the end of this century, did not exceed 100 tons per annum.

So far in this history, whenever chocolate has been mentioned, the reference has been to chocolate for drinking purposes. Chocolate for eating and cocoa powder were both as yet unknown to the public. The absence of the former may possibly be accounted for in this way: chocolate cannot be moulded unless it contains about 25 per cent of cacao-butter. If this is obtained by mixing cacao beans and sugar, we require to have present about 50 per cent of cacao bean, which makes a chocolate too bitter for eating to satisfy the public taste. It became possible to produce an eating chocolate sweet enough to be palatable, only when a supply of cacao-butter was available. This did not occur until the next century, and was intimately connected with the production of cocoa powder.

We have recorded how the cacao industry was nursed in Mexico, went to school in Spain, and then roamed over Europe. It remains to show how its romantic youth passed into a prosperous maturity.

5. FROM 1800 TO THE PRESENT DAY

Popularity Achieved and Perfection Approached

Since 1800 the rise to popularity of cacao preparations has been steady and continuous. Of innovations and changes, those which have had the most marked effect in increasing the consumption of cacao are as follow—

1. The introduction by Van Houten in 1828 of cocoa powder as we now know it.
2. The reduction of the duty to a low figure which was maintained constant for a number of years.
3. The great improvements which have taken place in the methods of transport.
4. Improvements in the manufacture of eating chocolate.

The beverage, chocolate, had one quality to which objection was often made. This was the richness due to the presence of a superabundance of fat. The art of pressing out a little of the butter was known in very early times, as is shown in the drawing of a press in the book on the use of chocolate by Nicholas de Blegny, published in 1687, but when Van Houten pressed out sufficient butter to make a *powdered* preparation possible he obtained at once a product which gave a more easily prepared drink. The British Government have always believed in chocolate for the Navy, and in the early years of the nineteenth century the amount taken by the Navy formed the mainstay of British consumption. In 1830 the British Navy consumed 176 tons. The British sailor to this day is given the old-fashioned chocolate, and excellent fortification it gives him against the salt breezes. A land-lubber would hesitate to sip this rich drink, on which floats a layer of fat; he would always prefer the lighter beverage obtained from cocoa powder, and one suspects that most sailors would also. The method of cocoa

production by pressing out part of the butter was not adopted in England until 1866, when Cadbury Bros. introduced their "Cocoa Essence." Fry & Sons adopted the process for their "Cocoa Extract" two years later.

Another, and older, method of reducing the fatty richness of the ground cacao bean was to mix with it some cereal product. This had been done from the earliest times; thus the Mexicans used maize. This addition, however, was condemned even as early as 1685. In J. Chamberlaine's translation of Colmenero's book, it states: "those that mix maize in the chocolate do very ill, for they beget bilious and melancholly humours. It is certain that it begets Choler and Windyness, and that they do not make use of this ingredient but for their own profit and the quantity of the chocolate." The objection to maize on the ground that it produces biliousness is amusing, but the motive for adding it is shrewdly stated. In 1837 Daniel Dunn invented the use of arrowroot in place of maize and described the mixture as "soluble cocoa." The battle for public favour between cocoas containing farinaceous material, and those which consisted simply and solely of the cacao bean from which part of the butter had been expressed, was a lengthy one, but it was evident that the victory had been won by the latter, from the day that it became recognized as a punishable offence to sell anything under the description of cocoa which contained any other substance than the cacao bean, unless the presence of these substances was fully disclosed.

The author keeps in affectionate memory the thick, heavy, glutinous liquid called cocoa that he once drank in his early youth; it was as sturdy as gruel. These mixtures of sugar and starchy foodstuffs with cocoa were very popular until the introduction of the pure cocoas, which have slowly but surely gained the day.

The mixtures continue to occupy a place in the national dietary because of their low price.

The circle of consumers in the latter half of the eighteenth century was widened by the reduction in price made possible by low duties. In the first few years of the century, cacao beans paid a preferential excise duty of 1s. 10d. a lb. if from British Possessions and 5s. 10d. a lb. if from foreign countries, while the customs also claimed a further duty of 2½d. a lb. on the finished product sold for home consumption. Commerce in cacao was unsettled by the continual alteration of these duties, until in 1853, Gladstone fixed the uniform rate of 1d. a lb. This remained constant for over sixty years, and would doubtless have continued to the present day but for the Great War. Under these fair conditions the charms and virtues of cocoa and chocolate have become universally recognized, and the consumption has increased by leaps and bounds, until to-day it is four hundred times as great as it was a century ago. Much has been written in praise of cocoa and chocolate. To those who have examined the dry statistics of consumption all these words are unnecessary. It is one of those cases where a column of figures is more convincing than a volume of rhetoric.

A Hundred Years of Cacao Consumption in Great Britain.

	Tons.
1825	143
1830	176
1840	910
1850	1,375
1860	1,442
1870	3,099
1880	4,713
1890	9,029
1900	16,888
1910	24,596
1920	50,651
1925	56,305

To the planter with his eye ever on the market price, who knows how rapidly the *production* of cacao beans

has increased, the above figures are cheering. He likes to hear that plenty of cocoa is being drunk, for he knows that it takes 2 lb. of beans to produce 1 lb. of cocoa powder. He is not so much interested in chocolate, because it takes only about 10 oz. of beans to produce 1 lb. of chocolate. The planter should note, however, that it is the chocolate industry which absorbs the cacao-butter which is a by-product of the cocoa industry. The chocolate industry not only absorbs it, but also pays a high price for this by-product, which thus enables cocoa powder to be sold at a figure which encourages consumption.

While chocolate for drinking is an ancient beverage which Europeans first saw, and possibly heard, drunk by the Aztecs over four centuries ago, chocolate for eating is a comparatively modern invention, and was not manufactured in England until after Queen Victoria came to the throne. The exact date is a matter of conjecture; Fry & Sons certainly sold " Chocolat Délicieux à Manger " in 1847, and Cadbury Bros. displayed chocolate at an exhibition in Bingley Hall, Birmingham, in 1849.

Chocolate for eating can be regarded either as sugar added to cacao or as cacao added to sugar. The makers of cocoa naturally became makers of eating chocolate. The three greatest firms in England have always run the two interdependent industries, cocoa and chocolate, side by side, but in recent years a number of confectionery firms have developed chocolate as an important side line. One of the oldest of these is Messrs. Joseph Terry & Sons, of York, who were founded in 1767, and were known for over one hundred years for their candied peels and boiled-sugar sweets before they built their chocolate factory in 1886.

Two important events in the history of eating chocolate will be casually mentioned here: they are the inventions of milk chocolate and of fondant chocolate.

The credit for being the first to conceive and produce a solid confection combining milk and chocolate belongs to Sir Hans Sloane, who in 1727 was first surgeon to King George II. His preparation was manufactured by Nicholas Sanders, and later by William White—it was expensive and was regarded as having great value as a medicament. The first confectioner to produce milk chocolate on a large scale was Daniel Peter, of Vevey, Switzerland, who invented his confection in 1876, and whose sales had reached important dimensions by 1894. The other event is the introduction of the so-called " fondant " chocolates, beautifully smooth productions, which in the last few years have practically driven the coarsely ground chocolate from the market. Both of these will receive further comment when the manufacture of chocolate is discussed.

All writers on the history of cocoa and chocolate are indebted to the late Richard Cadbury for his volume entitled *Cocoa; All about it*, by *Historicus* (1892). It is packed with curious old quotations that make it a mine of delight to the cocoa historian, and must have entailed many peaceful hours of reading. It is not easy to picture a successful business man, in the full stream of his career, poring over the old books and manuscripts in the British Museum. The three principal English cocoa and chocolate firms, Messrs. Cadbury, Fry, and Rowntree, have all been founded by men of character, all Quakers as it curiously happens, possessing a broad interest in humanity. Possibly the late Richard Cadbury found relief from the turmoil of business and the roar of the grinding mills in the tranquil seeking after knowledge and the lisping of turned leaves. He may be taken as a practical illustration of one who followed the Shakespearian precept—

> No profit grows where is no pleasure ta'en;
> In brief, sir, study what you most affect.

CHAPTER IV

BRIEF HISTORY OF THE SPREAD OF CULTIVATION

It may be fitting at this point to make some reference to the growth of cacao cultivation. In the fifty years that followed the discovery of America, the cacao tree was found to be growing in many places in the tropical parts of that continent, for example, in Brazil, Ecuador, Venezuela, and Mexico. It does not, however, appear to have been introduced into Bahia until 1746, when a French settler brought it from Para.

The Spanish were the first to begin planting cacao in other countries. They are reported to have planted it in the West Indies, in Trinidad, as early as 1525, and to have introduced it into the East Indies in Celebes in 1560. It was no inconsiderable achievement to carry the live cacao seeds half-way round the world, a journey which in those days would take several months. It has not thrived there, but Java, only recently of importance as a cacao-growing country, owes its first cacao plantations to this enterprise.

In 1634 the Dutch took possession of the island of Curaçao (where the famous liqueur oranges grow) and made this a port for the passage of the produce of tropical America to Europe. It was thus the Dutch who stimulated the Spaniards in Venezuela to grow cacao, and it was mainly due to the energy of the Jesuit missionaries—who engaged natives to form plantations on the borders of the Orinoco—that the industry thrived, and Venezuela began to ship cacao to Europe. About this time the Spaniards planted cacao in Jamaica, and somewhat later, in 1665, in Dominica, and in 1671 in the Philippines.

In spite of this activity in planting, practically the whole of the cacao consumed by Europe came from

tropical America, until the stimulating event in 1679. This was the arrival in France of the first crop from Martinique, the French having begun cultivation there in 1660. By the end of the eighteenth century this island had become very valuable to France, and, together with Santo Domingo, where the French planted cacao in 1665, produced practically the whole of the cacao consumed in France. The French were also responsible for planting cacao in Surinam in 1684, in French Guiana in 1734, in Madagascar in 1800, and in Cochin China in 1870.

Cacao was completely destroyed in many of the West Indian isles in 1727 by a "blast," presumably a hurricane. In Trinidad it was re-established about 1757 by some Aragonese Capuchin Fathers. At some time in the sixteenth or seventeenth centuries, the Spaniards introduced the cacao tree into Fernando Po, and although the output of cacao has only in recent years reached more than moderate dimensions there, its presence in that island led, in the nineteenth century, to the starting of cacao cultivation in other parts of West Africa, and this has had enormous consequences in the twentieth century. It appears to have been taken from Fernando Po to the small island of Principe and thence in 1822 to San Thomé, where, under the Portuguese, it has flourished, and from 1912 to 1918, of all the countries in the world, San Thomé produced in relation to its total area the greatest number of tons to the square mile. With less than half the area of County Surrey, it was the fourth largest producer in the world. It no longer holds this position, as since 1918 the crop has been greatly reduced by the attacks of an insect pest (thrips). The first cacao planted in the Gold Coast was also brought from Fernando Po. This was as recently as 1879, but the development here has been amazing, and the Gold Coast now yields nearly half of the total production of the world. The

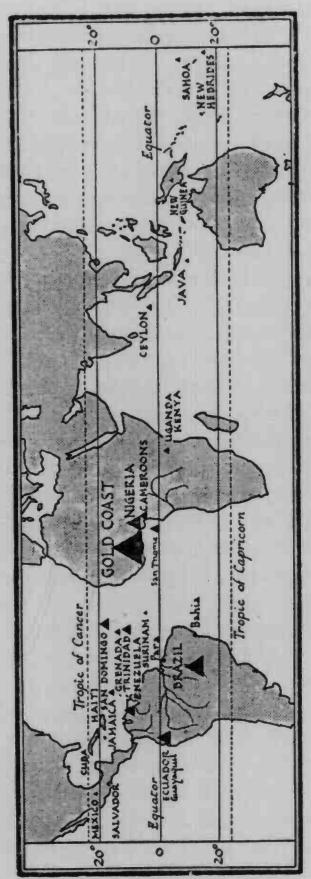

FIG. 6. THE CHIEF CACAO-GROWING AREAS
The areas are indicated by triangles, the size of which show approximately the relative volume of production

original cacao grown in the Cameroons also came most probably from Fernando Po.

While half the cacao produced in the world is grown in British Colonies, the British have had only a small share in the original planting. One instance, to their credit, not yet mentioned, is the case of Ceylon, where cacao from Trinidad was planted in 1834.

A map of the tropics showing the principal cacao-producing countries will be found on the opposite page.

CHAPTER V

THE RAW MATERIAL—CULTIVATION OF THE CACAO BEAN

In this chapter it is proposed to deal with the cultivation of cacao as practised to-day. The word cultivation conveys the idea of careful tilling of the soil, the application of manures, and generally the attention to all the details that keep the plant healthy and increase the yield. In this sense the word cannot be fairly used in relation to much of the cacao produced in the world. There are many cacao planters but few cacao cultivators. Roughly, one may say that cacao receives the same amount of cultivation, and the same varying degrees of attention, as the trees in our English orchards. Mr. Barrett once said to the planters of Trinidad, "Gentlemen, you have not *cultivated* cacao, you have only *picked* it." This pungent remark was doubtless intended to sting the Trinidad planters into greater activity; it would have been literally true if spoken to many thousands of cacao producers in other parts of the tropics. Yet in all countries a little care is taken, and such things as are traditionally considered beneficial are either done or intended to be done. Agriculture is the growth of centuries and the ways of men change slowly. In some parts of tropical America the way of cultivating cacao has been the same for several hundred years. Gradually, in each country, a method of cultivation and preparation for the market has been evolved suitable to the environment. Each method has distinctive features. As it will not be possible in the space at our disposal to describe all these methods, an attempt will be made to give the most approved procedure, with an occasional note on some of the more important variations.

Where does Cacao Thrive? The first question which the would-be planter has to decide is the choice of a suitable site. Cacao is essentially a native of the tropics, and plantations are unlikely to be successful outside the narrow margin of 20 degrees north or south of the Equator. The mean shade temperature should be about 80° F., and the temperature should very rarely rise or fall more than 15° F. above or below this point. The ground should preferably be a few hundred feet above sea-level, but the altitude should not exceed a thousand feet. Usually, as in Trinidad, which is about 11 degrees north of the Equator, cacao does not bear well at a thousand feet, although on the Equator, in San Thomé, it is possible to cultivate it at that elevation, and in places in Java and Venezuela even higher.

The cacao tree is very sensitive to wind. Like other trees it cannot stand against hurricane or tornado. On the Gold Coast and in Jamaica cacao is grown in spite of occasional hurricanes and tornadoes, but these are only exceptions that prove the rule, and a sheltered position should always be chosen. So sensitive is the cacao tree to the effects of the wind that it cannot thrive in a steady trade wind such as blows over a flat island like Barbados. It flourishes in sea-air, not in sea breezes; and the same problem faces the planter as faces the ventilating engineer—to provide plenty of fresh air without a draught. A gentle slope in a valley is generally ideal because it is sheltered and has the further advantage that the soil is rich and deep.

The rainfall also is very important. According to H. Wright, 50 in. is about the minimum and 200 in. about the maximum rainfall in the year for successful cacao cultivation. An even distribution throughout the year and a moist atmosphere compensate to a considerable extent for a low rainfall. Thus on the Gold Coast, at Aburi, where the Government Botanical Gardens (with successful cacao plots) are situated, the

rainfalls for the three years 1918–20 were remarkably low: 42 in., 35 in., and 36 in. respectively.

Cacao grows in a great variety of soils. Some planters look for a light loamy soil; all prefer a soil which is fairly porous, rich in humus, and of considerable depth. Mr. Stanhope Lovell finds in Trinidad that light sandy loams have many advantages and few disadvantages. They retain a more even temperature than heavier soils, they require less tillage, and they respond rapidly to treatment with pen-manure or mulch. They give trees which are healthier and grow less moss, but which do not withstand drought as well as those on some of the heavier loams.

Knowledge of soils is best learned by observation and practical experience. Chemical analysis is of some value, but until it can give us the amount of various constituents available to the plant-life in question, it will not be so useful, for judging the suitability of the soil, as observation on the spot of the condition and kind of vegetation growing upon it. This, together with the opinion of other planters in the district and of the local Agricultural Department, should be a sufficient guide. Good drainage is important, and water-logged soils are recognized as bad. Soils vary considerably in their power of retaining water and in their ability to raise water from a depth against gravity. The capacity for holding water should be high. An interesting observation by Sir Francis Watts appears to be related to this: he found in certain valleys in Dominica that, if the linear shrinkage of the soil on drying exceeds 10 per cent, cacao grown thereon will not thrive.

Every site has its peculiar problems. In Jamaica many estates would fail if it were not for elaborate systems of drainage. In Surinam, the plantations along the river-side are actually below water-level at high tide, and have to be surrounded by massive embankments to keep out the water. In such a situation it is evident

that the draining of the plantation must require great skill. On the other hand, in some places in Venezuela and Nicaragua, irrigation is essential to success.

In choosing the place for a plantation, the planter will not only select an area where his cacao trees are likely to bear well, he will also take into account certain economic considerations, of which labour conditions and transport are perhaps the most important His crop has to be collected and conveyed to the market, so that he will preferably choose ground near to a well-made road and convenient to rail and shipping.

Felling and Clearing. The planter having made his choice, the land has to be cleared of its wild growth before he can start planting. The outskirts of the primeval forest are a dense mass of matted vegetation; as we get deeper into the forest where the light is dim, the undergrowth begins to be less in evidence, and walking becomes easy save for the *lianes* which climb the trunks, reach the tree-top, and then hang down in graceful pendants to the very earth. The soil is black and almost bare. The felling is done in the dry season so that everything may be burned and, to facilitate this, the small trees and undergrowth are heaped and the large trees cut into sections. The planter has already carefully marked out the position for his bungalow, the drying platforms and fermentaries, and, in clearing, any suitable timber will be cut and put on one side to season. Much labour is required, and according to the character of the forest, high-woods or bush, the felling and clearing may cost anything from £3 to £6 an acre.

It is usual to leave all trees and bushes on the ridges for 50 ft. to 100 ft. each side. This serves several useful purposes, the chief of which is that of protecting the cacao from wind. To ensure this it is advisable to plant " wind-breaks," belts of native trees which are known to withstand gales, at right-angles to the prevailing wind, at intervals of about 1,000 ft. Useful

trees for this purpose are mango, Para rubber tree, and galba (*Calophyllum calaba*). Bamboo is approved by some planters, but others contend that its roots spread too readily, that it dries the soil, and that it is dangerous in case of fire. A good wind belt consists of mango-trees interspaced with a hibiscus hedge. (Strange, is it not, that the hibiscus, cultivated in England—in greenhouses—for its glorious crimson flowers, should be used in the tropics merely to " stop a hole to keep the wind away! ")

Planting and Seed Selection. Having determined the position of roads and drains, and having got the ground cleaned and thoroughly well turned, the planter proceeds to line out the ground and put stakes where the cacao is to be planted. The published results of the patient research being carried out by the Director of Agriculture in Trinidad are a much needed contribution to the question of the best spacing for cacao.[1] The usual distance in the past has been 12 ft. In 1914 plots were planted 12 ft. by 12 ft., 14 ft. by 14 ft., 16 ft. by 16 ft., 18 ft. by 18 ft. The results so far obtained are: from four to eight years after planting the yield per tree is generally greater in the more closely planted; at eight years the yield per tree in all cases is about the same; after eight years the wider planting begins to gain, and at twelve years the yield per tree is appreciably greater with the wider planting, and promises to further increase as the years pass. Thus thirteen years after planting the yield per bearing tree is as follows—

Planting Distance	lb. of Cacao per Tree per annum	Yield per acre In Bags of 165 lb.
18 × 18 ft.	4·29 lb.	3·0 bags = 495 lb.
16 × 16 ft.	3·73 ,,	3·7 ,, = 610 ,,
14 × 14 ft.	3·15 ,,	3·9 ,, = 644 ,,
12 × 12 ft.	2·01 ,,	3·3 ,, = 545 ,,

[1] See paper by W. G. Freeman in *Tropical Agriculture*, May, 1929.

The individual trees with the widest planting are yielding two and a quarter times as much as those with the narrowest. The planter, however, is much more concerned with the yield per acre than the yield per tree. The conclusion one draws is that if the planter can be content with a smaller total yield for the first twelve years of bearing, then in the long run he will gain by the wider spacing.

The distance the stakes are placed apart will also depend on the fertility of the soil and the kind of cacao planted—for Forastero, 18 ft. on very rich land, 15 ft. on good land, and 12 ft. on poor land. Criollo trees have generally been planted about 12 ft. apart, but Van Hall considers 15 ft. a more suitable distance. What a difference it would make to ease of cultivation if the trees were planted so far apart that one might safely use a plough! In most countries the trees occupy the corners of squares; there are advantages in the triangular planting (or rather in the quincunx form). If the lines are not straight, then later on (as Mr. W. MacLellan-Wilson points out in *Tropical Life*) " the plantation will appear all awry and crooked, and will be an offence to the meticulous and mathematical eye." " Well, well," the onlooker will say, " he *was* a careless planter who planted this field." Whereas, if the marking is carefully done, then from any spot on the plantation straight lines of stakes, and afterwards of cacao, will be seen radiating out, and the careful work done will be repaid a hundred times in the economic working of the plantation.

Another detail, which has a great effect on the future value of the plantation, is the seed selected. As mentioned in the chapter on the cacao tree, there are three species producing the cacao bean of commerce; *Theobroma cacao*, which is grown in all producing areas; the rarely-grown *Theobroma pentagona* or alligator cacao, the pod of which has five well-marked ridges

and is as nodular as an alligator's hide, and the seed of which resembles the Criollo variety of Theobroma cacao; and *Theobroma sphaerocarpa*, which is grown to a limited extent in San Thomé.

Of *Theobroma cacao* the planter can choose either the high-priced Criollo variety which only gives a moderate yield and is a delicate tree requiring rich soil, or the more hardy Forastero variety which gives a good yield of medium grade beans. The tendency, in recent times, has been to plant Forastero. Experiments conducted for the Director of Agriculture in Trinidad have conclusively shown that certain trees in any plantation consistently give high yields year after year, others consistently give low, e.g.—

PODS PER ANNUM[1]

	1912	1913	1914	1915	1916	1917	1918	1919
Tree *B*	91	125	123	206	129	191	60	223
,, *F*	3	6	3	7	5	25	3	21

Many of these poor bearers are strong and vigorous, and special manurial treatment does not fundamentally alter their yield. It is the nature of the tree. The results of these experiments (1913–29) in Trinidad, and those of Van Hall in Java, have shown that whilst the seeds of heavy bearers generally give trees of high productivity, the quality of heavy bearing is not necessarily transmitted. This property can only be determined by actual tests: as a result of these there are now available for the first time in history seeds from a few trees which have proved to have inherited the high-bearing capacity (60 per cent over the average) which characterized the mother plant. However, in general it is believed that none of the ordinary cacao trees in

[1] The number of pods is an indication, though admittedly only a rough indication, of the yield of dry cacao.

FIG. 7. PODS ON TRUNK OF CACAO TREE

INTENTIONAL SECOND EXPOSURE

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Fig. 7. Pods on Trunk of Cacao Tree

Trinidad (they are sub-varieties of Forastero) give seeds which breed true, and hence the selection of the seed of a tree on account of its high quality or its heavy yield is no guarantee that these characters will be reproduced. Professor Harland in his work on the fertilization of cacao flowers has shown that natural crossing occurs in 31 per cent of the cases,[1] and hence the present Trinidad cacao is a complex hybrid. There is evidently here a great field for research. The wonderful result obtained by Professor Biffen in producing a disease-resisting wheat, the equally wonderful result obtained towards a uniformity of quality in raw cotton, show the possibility, by scientific breeding carried over a considerable number of years, of producing a fine hardy type of cacao which would breed true. Until that is done, and, obviously, it will take a considerable number of years, one can only advise that whatever variety is selected, the seeds should be taken from healthy mature pods growing on trees possessing high vitality and good bearing properties.

The further question as to whether better results could be obtained from selected seedlings, or by budding or grafting heavy bearers on to hardy stocks, has also been under test in Trinidad since 1913. Whilst it is yet too early to give an answer to this question, it has already been shown that a heavy bearing tree does not necessarily transmit its properties by budding, but as a result of the trials certain trees have been found capable of transmitting uniformly high yields to the budded offspring. This represents a great advance.

Cacao may either be planted " at the stake," that is, in the field, or first grown in a nursery and transplanted. In either case a hole 2 ft. cube is dug and filled with top soil. In the first method, when the soil has settled, three or four seeds are put in, all save the healthiest plant being removed later. If grown in a nursery the

[1] *Genetica* IX, 1927, pp. 279–288.

seeds are set about 1 ft. apart, or planted in bamboo pots or in plaited coconut palm leaves. This means considerable labour; thus, for a small estate of 20 acres one will need 6,000 plants. Robert Louis Stevenson in his *Vailima Letters* gives an amusing account of the planting when he introduced cacao into Samoa in 1891. " You should have seen us; the veranda was like an Irish bog, our hands and faces were bedaubed with soil." The seeds are carefully shaded and watered in the nursery and are ready for transplanting about two months later, when they are from 1 ft. to 2 ft. high. The transplanting should be done just at the beginning of the wet season, after the first rains have fallen. Mr. W. MacLellan-Wilson has admirably conveyed the young planter's excitement during this process; it is true he talks of coffee, but his remarks apply equally to cacao. " Forgetting to drink his morning cup of coffee, neglecting to ring even the first bell (which by the way is an old bit of railway iron) to call his workers, he rushes off to the plantation to see if the rain has made any impression on the still empty coffee holes. Yes, there are marks where the welcome water filled the holes to varying depths of two, three, and four inches. That is surely sufficient moisture to start on! He thrusts his hand into the soil, incidentally in his excitement wiping it afterwards on his pyjama pants, and finds that it was a good soaking rain and the fates are propitious for planting. The excitement of that day he will never forget! From the nursery to the field, from the field to the nursery he ran; yes, actually ran! He re-arranged his men not once, but often, so that the digging out of plants, the carrying and the planting should have a relative balance in the operations. Finding finally a really careful native for the digging out in the nursery, the planter confined his attention entirely to the planting-out process. From hole to hole he danced, keeping a watchful eye upon his men, ensuring

that tap roots should not be bent, that hair rootlets should not be clumped, and that the plants should be in the middle of the holes."[1]

The Question of Shade. In the chapter on history it was mentioned that from the earliest times it was the habit of those who cultivated cacao to plant shade

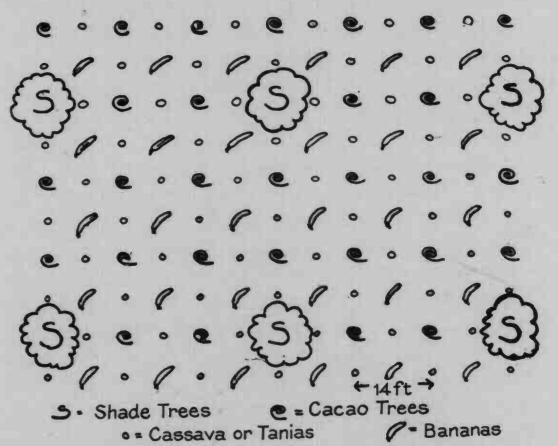

FIG. 8. DIAGRAM SHOWING LAYOUT OF CACAO PLANTATION

trees. It is agreed that the young plant just out of the nursery requires protection, and for this purpose the interplanting of bananas and tanias, or bananas and cassava, or pigeon pea (*Cajanus indicus*) is effective. The planter has to wait and watch more or less nervously for five years before the cacao is ready for harvesting, and these temporary shade plants, which are planted before the cacao, provide profitable "catch-crops" in the meantime.

The need for permanent shade trees is not so obvious. It is a disputed question for cacao and coffee alike,

[1] From the *Kenya Graphic*, reprinted in *Tropical Life*, June, 1922.

and by sensitive ears a continuous discussion of this question can be heard rumbling round the tropics—

Says old Mr. Trinidad: You forget that cacao originally grew in the shelter of the tropical forest. My cacao would die without shade.

Mr. Grenada: Mine doesn't; why should yours? Everyone knows that we planters depend for our crop on a good flowering, and flowering is promoted by light and air. Therefore, don't shade; don't smother.

Mr. Trinidad: Quite so, but it isn't the tree we aim at shading so much as the soil. And if we didn't protect the soil from sun and wind, we could not conserve the moisture in the soil, and the trees would wither.

Mr. Grenada: Agreed; and the best way to accomplish that is not by shading. In Grenada we keep the soil in condition by the use of wind-belts, by close planting, and careful tillage of the soil.

Mr. Trinidad: Careful tillage is too costly for me. By the way, did you hear of that mountain estate in Grenada where the shade was taken out and the estate ruined?

Mr. Grenada: No! Have you heard of the plots on the Agricultural Department's estate in Trinidad where the shade was taken out and as a result the crops greatly increased?

Mr. Trinidad: I have. They say since letting in the sunlight the borer beetle has been very prevalent. The crop certainly increased at first, but a wise man would wait many years before drawing conclusions.

The Trinidad tests have now been continued sufficiently long to warrant serious consideration. The yields on the experimental plots with full shade, half shade, and no shade have been recorded since 1911. The results are shown in the table below—

	Yield per Acre (in Bags of 165 lb.)	
	Total Bags in 17 years	Average per Annum
Full shade . .	88·5 bags	5·33 bags
Half ,, . .	115·0 ,,	6·76 ,,
No ,, . .	102·4 ,,	6·02 ,,

The full shade referred to above consisted in 1910 of forty-six Immortelle trees to the acre, i.e. the trees were nearly 30 ft. apart. In the intervening years some have

been blown down, and by the end of 1929 the shade trees were thirty-four to the acre. The conclusion drawn is that no shade is better than too much, and that not only higher yields, but health and vigour, and greater freedom from diseases and pests are obtained on this particular plantation by a large reduction in the usual amount of shade. Much less shade is required where there are adequate wind breaks, and there is for each situation its appropriate method. The principles on which agricultural science is founded are very general, and their application to particular cases must be equally particular.

The use of permanent shade trees is normally practised, save in Grenada, Jamaica, St. Lucia, Dominica, Brazil, Bahia, the Gold Coast, San Thomé, and Santo Domingo. All the finest shade trees belong to the *Leguminosae:* in the West Indies and other places the vermilion-flowered *Erythrina* (Bois Immortelle or "mother of cacao") is generally used and adds to the beauty of the plantations. It is planted at every third stake, that is, 45 ft. to 54 ft. apart. Only in a few countries are shade trees used which give a saleable crop; thus in Ceylon some use Para rubber and in Java the "kapok" tree (*Eriodendron anfractuosum*), which yields a silky fibre used for stuffing pillows and mattresses.

When shade trees and cacao have been planted, the roads made, trenches with a V-section dug, weeding attended to, etc., etc., the planter can begin to consider whether he will fork round the plants, whether he will use manure, and how he will train up the tree in the way it should go. In most producing areas the forking or hoeing of the soil on cacao plantations is considered entirely unnecessary, or, in some cases, even harmful. However, planters in some of the more progressive countries (Grenada, Ceylon, and Jamaica) are at one with the poet who says, "You tickle the earth with a hoe and it laughs with a harvest." In Surinam and Trinidad, though approved, it is little practised because of the high price of labour; in the latter country forking costs from 13s. to £1 per acre (or from a halfpenny to a penny a tree).

Mulching and Manuring. Taking the industry as a whole very little manuring is done, and so rapid is the decomposition of the soil in the tropics that many cacao plantations have flourished for years without any kind of manuring whatever. Whilst "mulching" is fairly common, and pen or farmyard manure is used when easily available, the use of artificial manures is altogether exceptional. There is a general consensus of opinion that "mulching" is highly beneficial, particularly if it is preceded by forking. To obtain a mulch, the weeds are cut, heaped, and allowed to rot, and then mixed with dried grass and leaves. The effect of a layer of this is to keep the soil in a moist, porous condition. It also has value as a manure. According to the *West Indian Bulletin*, Vol. 10, No. 2, the grass from one acre of cacao plantation contains—

Nitrogen	70·8 lb.
Phosphoric acid	21·1 lb.
Potash	94·8 lb.

At the beginning of the dry season the mulch is spread about 6 in. deep, over a circle 6 ft. in diameter, round each tree, care being taken not to place it in contact with the stem. It is dug into the earth at the beginning of the wet season.

In certain countries (Grenada and Ceylon are examples), applications of pen or farmyard manure are made. This is a costly process, but so valuable is it that it is to be regretted that all planters cannot either run a stock and grazing farm, or else have their plantation in close proximity to one.

In those rare cases where a planter desires to use artificial manure he can generally save himself expense

by consulting the local Agricultural Department, who usually have experience garnered from the use of manures on experimental plots. Basic slag has been found particularly good for soils requiring lime, but no simple rules can be drawn up, and an intimate knowledge of the soil is required to determine the correct mixture of artificial manures to use.

Pruning. In the early years, as with English fruit trees, pruning is devoted mainly to getting the correct tree-form to obtain maximum bearing. In order to produce a low, spreading and symmetrical tree, everything that grows upwards, save the main stem, is cut off; so is every branch which crosses another and threatens to touch it. A well-pruned tree will cast an equal amount of shade all round it and thus the trunk and roots will be protected from direct sunlight. At five years it will be about 10 ft. high and the spread of the branches 10 ft. in diameter.

Many planters subject their trees to a heavy trimming every third or fifth year. There is much to be said in favour of *light* pruning at more frequent intervals, say every year or second year. Light pruning increases the bearing area by promoting a branch crop and this is said to be less liable to disease than a trunk crop. It also encourages the growth of leaves, which protect the pods, when young and delicate, from fierce sun and heavy rain.

In later years, sappy branches may spring from low down the trunk and grow at a remarkable pace. These are called " watershoots " or " chupons," or by the uncomplimentary names of " suckers " and " thieves." They are deliberately permitted to grow by certain planters in Ecuador, Java, San Thomé, Ceylon, and Trinidad. In the last named it is the practice on a well-known estate to allow two watershoots to grow, one from the fork and one from the ground. Experts differ, but on the whole the majority agree that with

trees of normal growth all watershoots should be cut off.

While the excision of live wood to obtain a good tree-form is governed partly by taste, the removal of dead wood is a necessity if the trees are to remain healthy. This form of tree-surgery requires considerable skill. To keep the tree clean and healthy it is necessary also to remove the diseased pods, the little palm-like epiphytes called " wild pines " (*Catopsis*), which grow on the branches, and parasitic plants like mistletoe. The trees in San Thomé and the Gold Coast do not seem so liable to become covered with orchids and epiphytes as those in the West Indies. In Trinidad the writer has seen cacao trees so tufted with epiphytes that they appeared to belong to an extraordinary new species. On the Gold Coast the tree stems are sometimes allowed to become thickly covered with mosses and ferns. The artist finds the moss on the bark of the cacao tree one of its charms—he is delighted with the beautiful patches of russet-brown, silver, and green—but the too luxuriant growth of moss has to be checked by the planter when it threatens to smother the cacao flowers. Bass and wire scrubbing-brushes are sold for the express purpose of removing it, and in Grenada they spray their trees with a 1 per cent solution of copper sulphate to destroy it.

Science and Tropical Agriculture. One of the first indications of the appreciation of the fact that science would prove of value to the planter was the creation of botanic gardens in various places in the tropics, the first to be founded in the Empire being in the West Indies, at St. Vincent, in 1764. Later, various agricultural departments were established in the tropics, and they have done much for the countries they serve. They have helped in various ways, particularly by encouraging the planters to adopt the best methods so far known, and, as far as their other duties permitted,

by research for more accurate knowledge. They have shown that the better the scientists and the planters understand one another, the better for the industry. The most recent advance in this direction has been the opening of agricultural schools and colleges in the tropics. In 1917 one was opened at Peradeniya, Ceylon. In 1922 there was established in Trinidad a college, which has now become the Imperial College of Tropical Agriculture. A fine beginning has been made by this institution which is in an excellent position to carry out fundamental research. It has issued a comprehensive scheme of cacao research and, if sufficient support is forthcoming to enable this to be worked out fully, it will have far-reaching effects in the years to come. On the Gold Coast there is a Forestry Training Centre at Coomassie and a college at Achimota. With the help of these institutions the scientific training of young planters will continually improve, and the wisdom of individuals learned in the hard school of experience will gradually give place to methods founded on an ever-increasing body of knowledge.

Diseases and Pests. " Husbandry is not governed by judgment and labour, but by the most uncertain of circumstances, winds, and tempests." Although there is not so much truth in this observation to-day as when Cicero made it, it must be admitted that in spite of the advance of science, the planter is still at the mercy of Nature's moods, and particularly of that most uncertain circumstance, the appearance of pests and diseases. It is not possible to estimate the power of insect enemies and vegetable parasites to damage commercial enterprise in cacao planting, but it is certainly considerable, and however intelligent and industrious the planter may be, he is liable to loss from this cause. These attacks have one advantage, that the planter in his distress appeals, sometimes for the first time, for the best scientific help available. Frequently the advice

the " doctor " gives is to tell the planter to maintain on his plantation the conditions which make for healthy trees, together with some specific instruction on how to attack the particular pest or disease. The hand of the planter is being greatly strengthened by the knowledge which the various departments of agriculture are collecting: the departments in Trinidad, Ceylon, Java, Jamaica, Surinam, and the Cameroons having been pioneers in this direction.

(*a*) *Diseases due to Fungi.* The causes of these diseases were in the past a mystery to the planter, and their discovery has been the outcome of scientific research. A long account of these discoveries would make the danger from fungoid diseases appear greater than it is. The following are extracted from the formidable list detailed by Van Hall, as being some of the more important—

DISEASES OF THE CACAO TREE

Name of Fungus	*Name of Disease*	*Part Attacked*
Phytophthora Faberi	Canker	The stem
,, ,,	Chupon wilt	The leaves and twigs
,, ,,	Black rot	The pods
Diplodia cacaoicola	Die-back	The stem
Marasmius perniciosus	Witch Broom	The leaves and twigs
,, ,,	,, ,,	The pods

The reader will notice that a single fungus, *Phytophthora Faberi*, causes stem canker, chupon wilt, and black rot of the pods. This and *Diplodia cacaoicola* (Thyridaria tarda) are the most widely distributed of fungoid diseases. The Surinam witch-broom disease, though not widely distributed, is important on account of its disastrous effects. Happily it has not been seen save in Surinam, British Guiana, Demerara, Ecuador, and Trinidad. It is called witch-broom because it induces extraordinary growths resembling brooms. The

effects of its ravages in Surinam in the years about 1900, were shown by the diminution of the cacao crop; in 1895 the amount of cacao exported was 4,450 tons, and by 1904 it had fallen to 856 tons. The method of fighting the disease consisted in removing the entire leaf-bearing crown of the tree, putting black tar on the wounds and then spraying with a 3 per cent solution of blue stone (copper sulphate) to destroy any spores. The success which attended this treatment is reflected in the amount of cacao exported, which, for the thirteen years prior to the destructive drought of 1926, averaged 1,500 tons. In 1922 it was reported that this deadly disease had broken out in Ecuador, in the Balao district, and steps were immediately taken to control it. In spite of these the output of cacao in Ecuador had fallen by 1927 some 10,000 tons below its former average production, and it is feared that the harvest will never again reach its former magnitude. By the irony of fate in Trinidad, where a few years earlier the Board of Agriculture had vetoed the importing of cacao plants or seeds from Ecuador for fear of introducing disease, there was discovered in 1928 witch-broom on certain plantations. Happily the attack is a mild one, and it is hoped that as Trinidad possesses a much less humid climate than Ecuador, the active measures taken will keep the disease in check.

Each disease requires its appropriate cultural treatment, and it is agreed that it is better to prevent their occurrence by sound cultural methods, than to attempt their cure by such methods as spraying, pruning, etc. Spraying, on account of its cost, is not a common practice. Copper salts are the fungicides most frequently tried; thus for *Phytophthera Faberi* the spray used is Bordeaux mixture. One gallon of this is required to spray each tree, and Mr. J. B. Rorer stated in 1911 that the labour and chemicals cost 10 dollars per 1,000 trees, or about one halfpenny per tree. The

spraying must be repeated at intervals to obtain material improvement.

(*b*) *Pests.* Besides the diseases due to fungi, there is another large group due to insects. The following are examples of some of the common pests—

INSECT PESTS OF THE CACAO TREE

Name of Insect	*Popular Name*	*Part Attacked*
Scapteriscus didactylus	Mole cricket	The root and stems of young plants
Steirastoma depressum, etc.	Borer beetles	The stem
Heliopeltis	Heliopeltis bugs	The twigs and pods
Selenothrips rubrocintus	Thrips	The leaves and pods

Although, no doubt, healthy trees are better able to withstand the attacks of insects, a number of these pests are always present even in countries where cultivation is carefully and scientifically carried out. Thus in Grenada in 1920, the following insects were recorded as locally severe: Thrips (*Heliothrips rubrocinctus* Giard), the acrobat ant and termites; while the presence of borer beetles, scale insects, and mealy-bugs was also noted.

The planters have generally recognized these insects as enemies; they have not, however, always known sufficient of their habits to determine the most satisfactory means of destroying them, and the researches carried out by the various departments of agriculture have been of material help in this direction.

Spraying is moderately successful in some cases; thus to destroy the mole cricket a spray of Paris green is recommended, and thrips are killed by spraying with kerosine emulsion, or an emulsion of tar in caustic alkali. In Navel's book[1] on the principal enemies of cacao there are illustrations showing a small army of

[1] *Les Principaux Ennemis du Cacaoyer aux Iles de San Thomé et de Principe*, by H. C. Navel (1921).

workers in San Thomé going into the plantation to fight the thrips with spraying machines. The heliopeltis bugs have an annoying indifference to sprays, and an attempt is made to reduce their numbers by catching them with the help of cobwebs or sticky substances. Sprays are useless for the borer beetle as the larvae (whitish translucent grubs about 1 in. long) spend their time cutting spiral tunnels underneath the bark. The usual method of dealing with this pest is to cut along the tunnel, destroy the larvae, and tar the wound.

Before leaving the subject of pests, mention must be made of rats and squirrels, which are responsible for losses of cacao as a result of their attacks on the pods. According to Van Hall, in San Thomé the loss caused by rats is estimated to be about one-fifth of the whole crop. Everyone thinks the squirrel a pretty little fellow, but he is a wanton waster of cacao. He has a playful way of gnawing a hole in the pod to get at the sweet pulp, and scattering the beans on the ground.

Books on Cacao Cultivation. The account of pests and diseases given above is very fragmentary, but the writer felt it was better to give a few brief notes than to ignore entirely so important a subject. This may be a suitable place to refer to the chief works on cacao cultivation, for the benefit of those readers who wish for a detailed study. The first modern work on the subject was *Cacao, How to Grow it*, by Sir Daniel Morris of Jamaica (1882). Since then a number of fine works have been written by Olivieri and Hart in Trinidad, by Wright in Ceylon, by W. H. Johnson in Nigeria, and by Van Hall in Java. *Cocoa* by C. J. J. van Hall is, in the writer's opinion, the most up-to-date and comprehensive book on cacao cultivation.

CHAPTER VI

HARVESTING AND PREPARATION FOR THE MARKET

Harvesting the Crop. The cacao tree usually bears at five years, may be considered mature at ten or twelve years, and continues to bear for thirty or forty years. This is only true if reasonable care is taken—the average life of a tree on the Gold Coast being much less.

At all seasons of the year a few pods are ripe for picking, but the principal harvest lasts about three or four months. The heaviest cropping period generally commences in January in Trinidad and Grenada; in March in Ecuador; in April in Venezuela; in May in San Domingo; in July in Para, and in October in Bahia, San Thomé, and the Gold Coast.

Having studied the cacao tree one becomes curious to know how the fruit will be picked. The trees are not stout enough to bear climbing, the pods do not fall when ripe, and to drag them off, as they do in Para, with a loop of rattan, injures the "cushions" from which they spring. While those on the trunk and lower branches are cut off with a sharp cutlass, a special picker is used to bring down those high in the branches. This consists of a knife on a long rod, and as wounds on the tree are dangerous to its health, considerable ingenuity has been exercised in making a knife which easily cuts off the pods, but which cannot, however carelessly handled, cut the bark of the tree. This curious method of picking the fruit, by means of a knife at the end of a long pole—the instrument is called a goulet, cocoa hook, or podadera—is used all over the world, and is, as far as the author knows, peculiar to cacao. In some places, e.g. the Gold Coast, pruning scissors worked by a cord have been tried.

At first one wonders at the keen eyes of the native pickers, which enable them to detect the subtle colour changes in the pods which denote ripeness, until one remembers how readily one can judge the ripeness of the various kinds of apples in which the colour changes are equally subtle.

The pods which fall to the ground are gathered by the women into baskets which, when full, they carry on their heads, and convey with a graceful leisurely motion to an appointed place in the plantation. Gradually a heap of the ripe fruit is made. It would be an advantage to leave these pods for a day or two before breaking them, but, in spite of watchmen, the danger of theft is too great to allow of this. The workers squat round the heap and cut the pods open. The old methods of striking one pod against another, or banging them on the ground or against a log of wood, are now happily rare. A sharp cut with the cutlass, a neat turn of the wrist and the top half of the pod is off. The beans are now scooped out, preferably with a wooden spatula, and heaped on banana leaves. Any defective beans or diseased pods are carefully kept separate from the rest.

The glistening, snow-white, or heliotrope-tinged mass of beans is wet and mucilaginous, and the fruity juice drips from it as it is conveyed in baskets on the backs of mules, or in small railway trucks as in San Thomé, to the fermenting house.

The Fermentation Process. In the preparation of the raw cacao for the market, no process which it undergoes is more curious, or presents more interest to the inquiring mind, than that of fermentation. Although cacao is fermented in nearly all the countries in which it is produced, the exact object and original intention of this process remain obscure. While good methods of cacao fermentation have been practised for many years, the literature on the theory of the subject—already

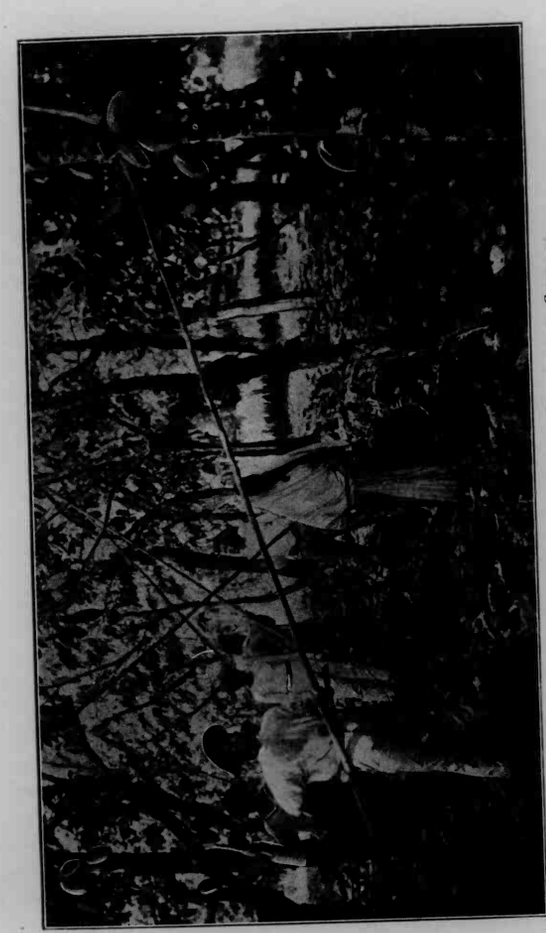

FIG. 9. HARVESTING CACAO WITH PICKER AND CUTLASS

INTENTIONAL SECOND EXPOSURE

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FIG. 9. HARVESTING CACAO WITH PICKER AND CUTLASS

voluminous—contains no full explanation which is generally accepted. The practice of fermentation is comparatively simple, but the actions and reactions which occur are complex and difficult to describe in non-technical language.

One is quite used to the idea of the production of beer by the fermentation of an extract of malted barley, and of the production of wine by the fermentation of grape juice, but to some readers the association of cacao and fermentation will be new. Although the word "fermentation" is correctly used in connection with cacao to indicate a kind of spontaneous decomposition which produces alcohol, it may easily convey a wrong impression, for the small amount of alcohol produced is not the object or the end of the process, the alcoholic liquid being a by-product which is thrown away. In the production of beer, and in the leavening (rising) of bread the presence of yeast is essential; it is equally necessary in the case of cacao, but whereas with the two former the yeast is deliberately added, in the fermentation of cacao the yeast falls in accidentally from the air or comes from the outside of the cacao pods, or from the sides of the vessel in which the cacao has been put, and is distributed by a tiny fruit fly (*Drosophila melanogaster*). In this respect it resembles cider manufacture, the fermentation in which, until recently, had never been started by a selected and carefully cultivated yeast, but by the mixed "wild" yeasts of the air. Yeast cells are nearly always present in the air, and are to be found in quantity in and near places where fermentation is carried on.

There is not yet agreement as to the particular yeast which is mainly responsible for cacao fermentation. Beer and wine yeasts have been found, as well as the wild yeasts occurring on the outside of fruits, etc. While Chittenden mentions *Saccharomyces cerevisiae*, Preyer names a special yeast, *Saccharomyces*

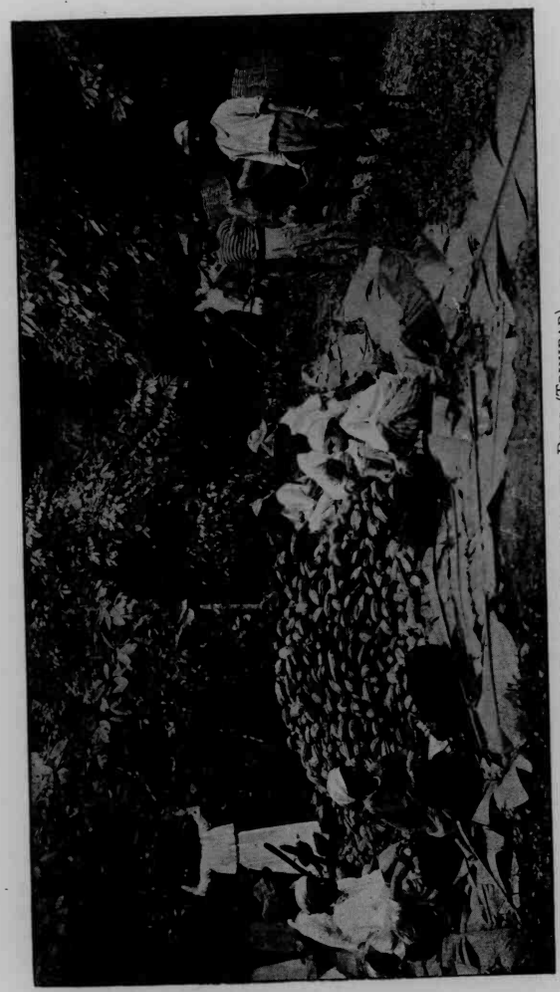

FIG. 10. BREAKING THE PODS (TRINIDAD)

INTENTIONAL SECOND EXPOSURE

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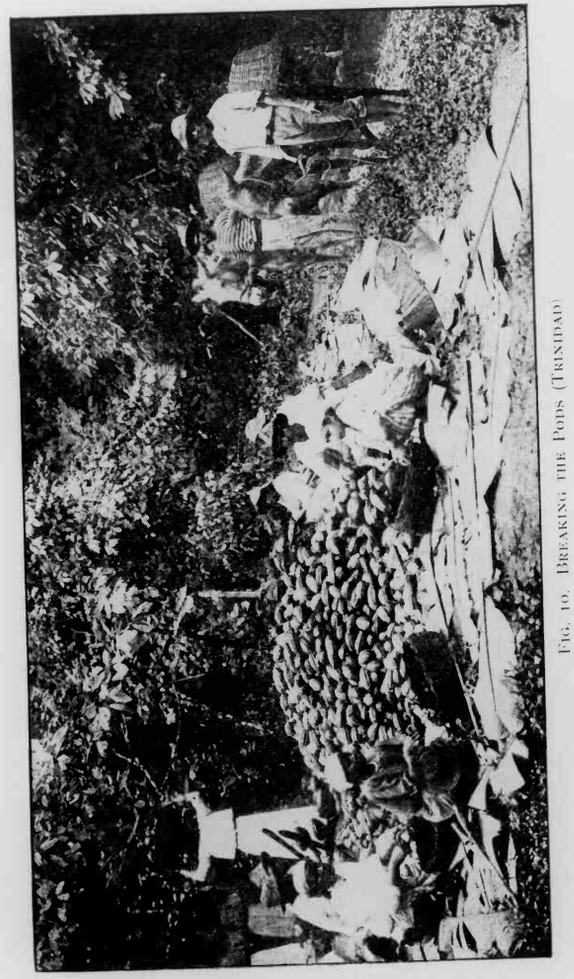

Fig. 10. Breaking the Pods (Trinidad)

theobromae; Loew says it is *Saccharomyces ellipsoideus*, and Davies states that *Saccharomyces apiculatus* is found in the early stages of fermentation. Probably in different countries different yeasts occur. Possibly, in the near future, some enterprising firm will prepare for sale to the planters a suitable culture of yeast as a "starter," and save the planters twenty-four hours on every fermentation; or Nicholls' scheme will be adopted and the local Department of Agriculture supply a culture. Some scientists would wish the planters not merely to add, but to maintain, a pure culture. They have yet to prove, however, that there are practical advantages in this refinement. One cannot obtain a perfectly pure culture on the fermenting beans unless the beans are first sterilized to destroy adventitious organisms, and sterilization is more than likely to destroy the wonderful substance called an oxidase, which, as will be shown later, plays an important part in the changes in the interior of the beans.

Fermentation of the Pulp on the Outside of the Bean. If the planter were to pack the pulp-covered beans straight from the pod in bags and send them wet and juicy to market, they would rapidly decompose and become mouldy. He must make them stable and prevent them "going bad," and the first method he would naturally try, to obtain this condition, would be to dry the beans. He would then discover that dried pulp has an unfortunate tendency to absorb moisture from the air and become soft and sticky, in which condition it easily becomes mouldy. It happens, however, that when cacao beans are put in a heap and kept warm they ferment, whether one desires it or not, and it was probably quite accidentally discovered that after fermentation the pulp is diminished in amount and changed in character, and, consequently, the beans are more rapidly dried, and more easily arrive at a stable state. At the same time it must be admitted that by

simple drying in the sun, as is done in a few countries where the more primitive methods exist, a moderately stable product can be produced, but this dried and unfermented cacao cannot be sold at so high a price as the fermented article from the same country, the majority of cocoa and chocolate manufacturers preferring fermented to unfermented cacao. In some countries the "wet" cacao, i.e. the pulp-covered beans fresh from the pod, is simply put in heaps; in others it is put in boxes fitted with more or less simple arrangements for allowing the liquid which drains from the pulp to run away. The mucilaginous envelope round the beans gradually loses its structure and its glutinous nature, and becomes, when the fermentation is completed, a very thin coat of paste which readily dries on to the outer shell of the bean.

In order to obtain a good fermentation, the planter finds that it is advisable to retain the heat as far as possible, to allow the liquid produced from the pulp to drain away, and to let air have access to the beans. Any arrangement for fermenting cacao which satisfies these conditions will give a good product. Cleanliness is essential, as otherwise unusual fermentations and decompositions may take place with the production of moulds and mildews. It will be realized from this that a hole in the ground is not a satisfactory fermentary and, happily, this primitive method of making a receptacle is now little practised even on the Gold Coast. A great variety of vessels is used, but boxes are the most popular. The planter calls them "sweating boxes," an expression which is descriptive if not beautiful. They are made of slate, stone, cement, or more usually of some hard native wood. They vary greatly in dimensions, a convenient size being a 4-ft. cube. The floors of the wooden boxes are either perforated or made of slats fixed about $\frac{1}{4}$ in. apart. This allows the juice to drain away. The same result is obtained in

vats by having a sloping floor. The boxes are raised about 1 ft. from the floor on blocks; this allows the air to circulate freely beneath the boxes, and the juice to drop into the channels and run out of the building. The beans, which have been freshly scooped out of the

FIG. 11. FERMENTATION OF CACAO (JAVA)
(Reproduced from Van Hall's *Cocoa*, by permission of Messrs. Macmillan & Co.)

pods, are put in the boxes to a depth of 2 ft. to 3 ft. They are levelled down and covered with one or two layers of freshly cut plantain or banana leaves. This covering prevents the heat produced by fermentation from escaping, and the rising temperature causes an acceleration of the speed of fermentation. In a box containing 5 cwt. to 10 cwt. of Forastero cacao, the temperature will rise in 24 hours to 89° F., 48 hours to 98° F., and 72 hours to 115° F. After that period

the temperature is maintained and preferably should not rise above 120° F.

Of fermentation, as we commonly think of it, accompanied by a vigorous evolution of bubbles of carbon-dioxide, one sees little, although on the top of the mass of beans a few bubbles can be found here and there. One would naturally expect if a large heap or boxful of beans were allowed to remain undisturbed, the accidental presence of yeast cells would cause a brisk fermentation in isolated patches and not evenly throughout the mass. That this actually happens can be easily tested by plunging in the hand, for the fermentation causes an increase in temperature, and the fermenting beans will feel quite hot while the others are cool. In order that all the cacao beans may be equally fermented, the planter usually mixes them by turning the heap, or transferring the cacao from one box to another, once a day. Turning the beans in the hot atmosphere of the fermentary is a laborious process, and planters are still waiting for some ingenious person to invent a cheap fermentary which enables the beans to be easily mixed. In the illustration of the fermentation of cacao in Java the boxes are arranged in steps, an arrangement which reduces the labour of turning.

Different kinds of cacao require different periods of fermentation, the delicate, fine and thin-skinned kind (Criollo) requiring only two days, while seven days is often necessary for the more hardy and harsher varieties (Forastero and Calabacillo). The fermentation of the pulp, which contains sugars, proceeds in somewhat the same way as the fermentation of grape or apple juice when it is freely exposed to the air: at first alcohol is produced, and later the pulp and juice develop acidity and become sour. The production of acidity is due to the presence of the well-known bacteria which produce vinegar, and their

INTENTIONAL SECOND EXPOSURE

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distribution is said to be effected by a minute fruit fly (*Drosophilia*).

In the vicinity of the fermenting beans one perceives on the first day a faint fruity odour, which in two or three days becomes stronger and more reminiscent of alcoholic beverages, and towards the end of the fermentation the odour begins to resemble that of sour cider. During the same period one sees the pulp diminish in quantity and change from snow-white to dirty brown. A planter judges entirely from such external signs when the cacao is sufficiently fermented, although the extraordinary changes which occur in the bean itself are of greater importance to the cocoa manufacturer.

Changes Due to Fermentation Inside the Bean. The actions which take place in the fruity pulp are similar to those which occur generally in fruit juices or liquids containing fermentable sugars, but the reactions in the interior of the bean are more rare and peculiar. The acidulous liquid penetrates and permeates the bean, changing the violet of the Forastero beans to a pink, and spreading the colour more or less evenly throughout the bean. Other and more subtle effects are produced. Of these, only the most important one has received much consideration; this is a change of colour due to the development of a brown substance in the bean. Whilst this phenomenon is not so well known as that due to yeast fermentation, it is not difficult to cite familiar examples. Everyone has observed the browning of apples and pears when they are bruised or cut and left exposed to the air. Many will have noted the same colour change in peaches, grapes, acorns, horse-chestnuts, and broad beans. Those who know the tropics will have noted the development of a brown colour in kola nuts and in tea and tobacco leaves. The change in colour in cacao beans, as probably in all the cases cited above, is due to the action of the oxygen of the air on particular constituents, known generally as

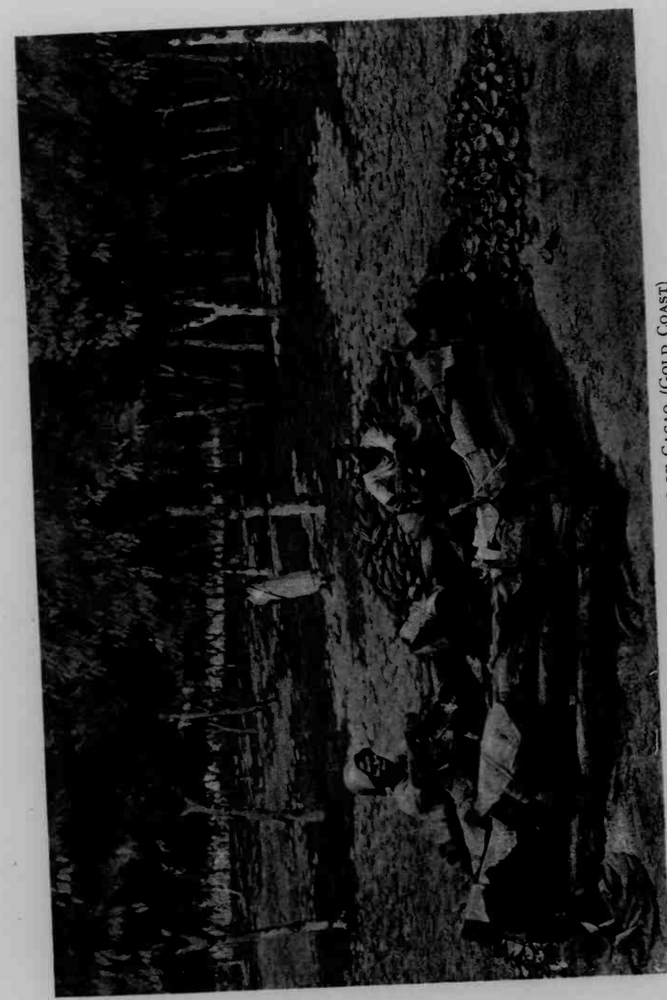

FIG. 12. FERMENTATION OF CACAO (GOLD COAST)
(Reproduced by permission from one of the Imperial Institute dioramas)

INTENTIONAL SECOND EXPOSURE

distribution is said to be effected by a minute fruit fly (*Drosophilia*).

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tannins—in this case cacao catechin, and cacao catechu-tannin. The oxidation of the tannin to a brown substance is rendered possible by the presence in the bean of minute quantities of an oxidase, which is a substance of unknown constitution and composition formed in living matter and capable of starting oxidation. The oxidase, so to speak, lubricates the machinery of oxidation.

At the end of the fermentation everything inside the skin of the cacao bean, originally white or purple, begins to be tinged with brown. The colour change continues during the drying, and by the time the bean is quite dry, if it was originally white or pink, it is now cinnamon brown, and if it was originally purple, this colour is darkened by the presence of more or less brown. This colour change may be likened to that occurring in sliced apples when they are dried in the sun, with this difference, that the cacao bean is neither skinned nor cut. Notwithstanding this, the oxygen penetrates the bean, which gradually becomes browned throughout. This is one of the things the wise planter strives after, to produce a bean with a beautiful brown interior. It has been generally noted that accompanying this change in the colour of the bean is a change of taste, the original bitterness, or rather astringency (due to the tannins) being materially reduced. This reduction of astringency is regarded by manufacturers of cocoa and chocolate as an important and advantageous action. It requires an experienced palate to appreciate it. On the other hand, the difference in *colour* between the fermented and unfermented cacao is obvious to everyone; thus for example, an unfermented Accra bean when dried is the colour of slate, and when fermented is brownish-purple.

Of the various other effects of fermentation, the loosening of the shell, the opening up of the bean and the development of the acid odour deserve mention.

The bean would seem to have a taste for the acidulous beverage which the pulp forms during fermentation, for the bean sucks a small fraction of it in and becomes as round as an egg, the skin being stretched to the utmost and freed in places from the cotyledons. On drying, the skin wrinkles a little and the inside of the bean contracts and shows interstices. This is another character the wise planter hopes to see on breaking the beans—an open interior.

During the drying which follows the fermentation the alcohol is lost, while traces of pleasant-smelling esters and more than traces of acetic acid are retained. These give to the fermented beans of commerce their characteristic vinegary odour.

Various interesting suggestions for improving the time-honoured methods of fermentation, or of substituting totally different methods to attain the same end, have been made, but not one of these has found favour with the planter or attained commercial importance. Those readers who wish to know more of cacao fermentation should study *The Fermentation of Cacao*, edited by H. Hamel Smith.

The Cacao Juice or Sweatings. Chemists, by their researches, have given value to so many by-products that it seems reasonable to hope that cacao sweatings will one day repay the cost of collection. At best the cacao juice is carried by drains to a stream, at worst it is allowed to saturate the ground in the neighbourhood of the fermentary. The quantity of sweatings obtained varies with the amount lost between plantation and fermentary, the wetness of the season, etc., but it may be taken to be at least 30 gallons for each ton of dry cacao beans produced. Thus on an estate of 200 acres, yielding, say, 4 cwt. of cacao per acre, about 1,200 gallons could be collected from the fermentary in one year. Like all fruit juices it is an unstable liquid, rapidly developing alcohol and becoming sour; hence it varies

in composition according to the length of time it has been standing. Its specific gravity is about 1·060, and it contains about 14·5 per cent of solid substances in solution. The following is the average composition of sweatings from Trinidad cacao. The figures were determined in Messrs. Cadbury's Research Laboratory—

CACAO SWEATINGS

	Per cent
Water	85·0
Cane sugar	trace
Other sugars (reducing sugars)	10·0
Jelly (mucilage and possibly pectin)	2·0
Acids (citric, acetic, etc.)	1·0
Salts (potash, calcium, and magnesium carbonate)	0·5
Albuminoids (N. = 0·05%), tannins, alcohol, etc.	1·5
	100·0

Besides the above there are traces of theobromine (·03 per cent) and caffeine (·005 per cent). Its composition shows that, suitably treated, it might yield an alcoholic beverage, a vinegar, or a jelly. That none of these are being produced on a commercial scale is partly due to its unstable character which renders it difficult to maintain a standard article, and partly because the quantity produced per day by each fermentary is small. These objections would be diminished if, by co-operation among the planters in one district, a central factory could be established.

Drying. The processes of fermenting and drying are referred to collectively as curing. The fermented bean contains about 45 per cent of its weight of water, and to obtain a stable product this must be reduced to 5 or 6 per cent. The great bulk of the cacao produced is dried by spreading it in a thin layer and turning it over and over in the sun for at least three days. In Ecuador this operation is performed on matting, made of split bamboos, which lies on a flat stretch of sandy soil. These enclosed drying grounds are called

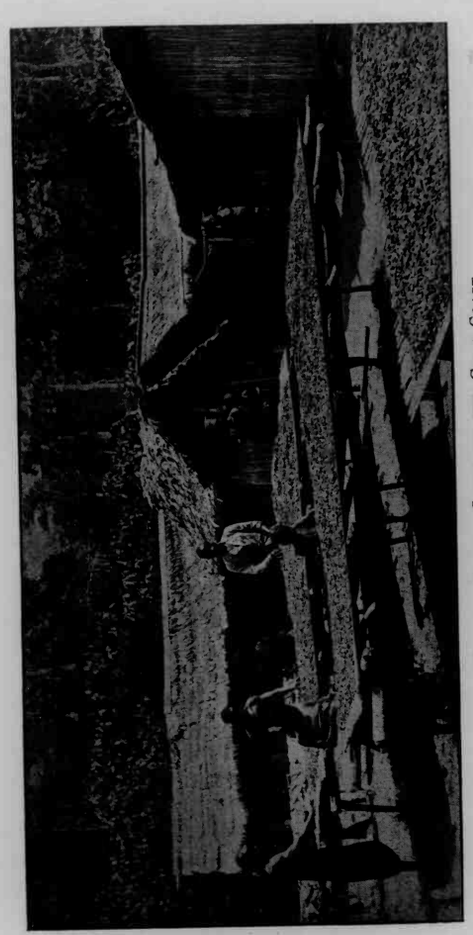

FIG. 13. DRYING CACAO ON THE GOLD COAST
(On mats, made from bamboo or the mid-ribs of oil palms, supported by trestles)

INTENTIONAL SECOND EXPOSURE

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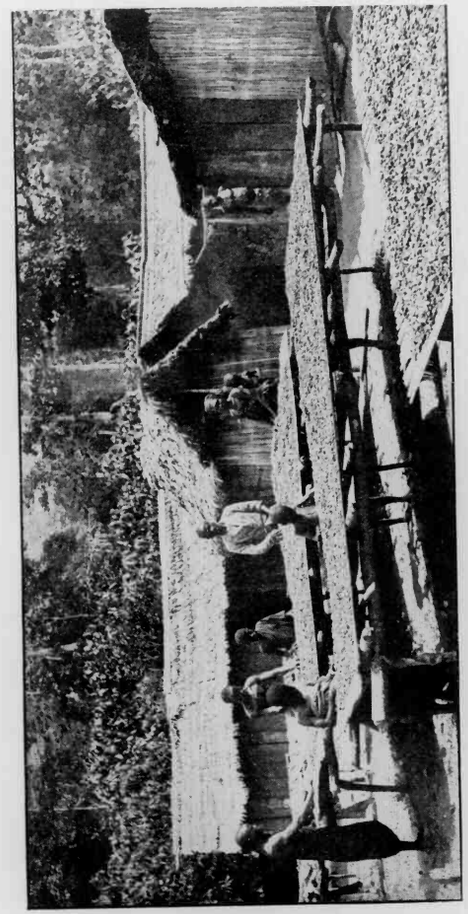

FIG. 13. DRYING CACAO ON THE GOLD COAST
(On mats, made from bamboo or the mid-ribs of oil palms, supported by trestles)

barbecues[1] or tendales. On the Gold Coast the merchants and others dry cacao on cement floors, and it has been suggested that a drying floor of Portland cement, made impervious with "pudlo" and coloured black, would be ideal. In the West Indies large wooden trays or platforms are used, called *boucans*.[1] In order to shelter the beans when rain comes on, and to shield them from the excessive heat of the mid-day sun, the platforms are fitted with sliding roofs, or the trays are arranged to run on rollers one under another. The area required to dry the product from each 1,000 trees (about 15 cwt. per annum) is at least 80 sq. ft.

The climate in some districts is such that the cacao cannot all be dried by exposure to air and sun, and unless the planter can assist the drying by artificial means, he is faced with severe losses due to his cacao going mouldy. Drying by artificial means is used extensively in the Cameroons, Ceylon, Grenada, Bahia, San Thomé, and Costa Rica. In some cases a fire can be lighted to heat the platforms, either by hot air or hot-water pipes, when drying is proceeding too slowly. In San Thomé there are covered-in drying platforms which are always heated by artificial means. In Grenada the author saw a room fitted with trays on which, by means of air warmed by hot pipes, the cacao was dried in 36 hours. Various enterprising engineering firms sell drying machines, and these are being used in increasing numbers by the planters.

From the point of view of quality, sun-drying is always to be preferred, because the changes due to oxidation, which occur during fermentation, are continued under natural conditions during drying. Some

[1] The meaning of the two words *barbecue* and *boucan* are closely related. Barbecue is Spanish in origin, and meant a framework on which meat was smoked or dried. Boucan is Carib for a similar thing. The French piratical adventurers, who so remorselessly plundered the Spanish in the West Indies during the seventeenth century, dried or smoked their meat on a boucan, and hence were called buccaneers.

planters encourage these changes to continue during the night by heaping the cacao on the drying platform, and sufficient oxidation occurs to cause a rise in temperature.

It is commonly stated that oxidases are destroyed when heated to 60–65° C. (140–149° F.). Fickendey has

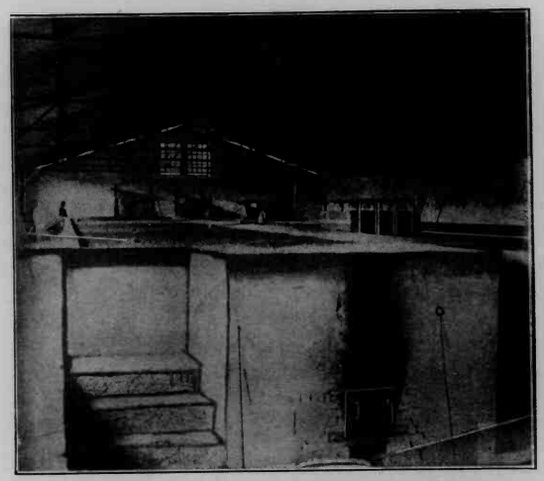

FIG. 14. DRYING CACAO BY ARTIFICIAL HEAT
(SAN THOMÉ)
(Reproduced from *Les Principaux Ennemis du Cacaoyer*, by permission of the author, H. C. Navel)

shown that the oxidase which occurs in cacao beans is destroyed between 70–75° C. (158–167° F.), so that it is clear that in the early stages of drying the temperature of the beans should never rise above this. Too often, in artificial drying, quality is sacrificed to a spurious efficiency. There is always a tendency to hasten the process and hence either high temperatures are used which destroy the oxidase, or the drying is done in vacuo and there is no oxygen to complete the oxidation.

INTENTIONAL SECOND EXPOSURE

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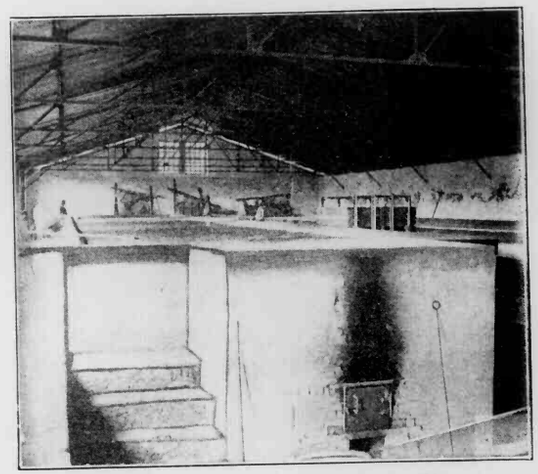

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Sometimes worse errors are committed and the beans become very brittle and even slightly burned, or they may become tainted with the odour of the smoke which comes from the wood fires used for heating. The beans are easily spoiled, and with artificial drying skill is needed to avoid getting a dark uneven product.

So far in our observations on the cultivation and preparation of cacao, there have been few instances where the planter has received assistance from the engineer, but in the case of drying it is the engineer who has pointed out that sun-drying is costly, tedious, imperfect, and uncertain, and a large number of engineering firms have given attention to this subject. There is a great variety of machines on the market for the planter to choose from, and if he does not wish for ever to be at the mercy of the weather, he will be wise to ascertain the costs and see whether they would pay on his particular plantation. The simplest method of drying is by hot air, and for small plantations the simple tray-drier, "Mayfarth's Patent" is the most suitable. For larger plantations which can afford a steam engine, the Gordon rotary drying machine is often used. The Brumutro drier is well spoken of by Prof. Paul Preuss, and has been used in the Cameroons. Emil Passburg and George Scott & Co. make excellent vacuum drying machines, but the author has not had the opportunity of judging the characteristics of the cacao dried by this method. The illustration of the Gordon rotary drying machine shows part of an installation in one building containing six machines, each capable of taking a charge of 10,000 lb. of wet cacao. It is driven by water-power and the air for the drying machines is heated by steam, one boiler supplying steam to the six machines. The cacao is fermented in an outside building, from whence it is lifted by an elevator to a conveyor which carries the wet cacao to

a line of bins. The bins will be seen over the dryers, and the cacao is fed from them into the dryers.

The United Fruit Company in Costa Rica have carried the use of mechanical aids a step further. They

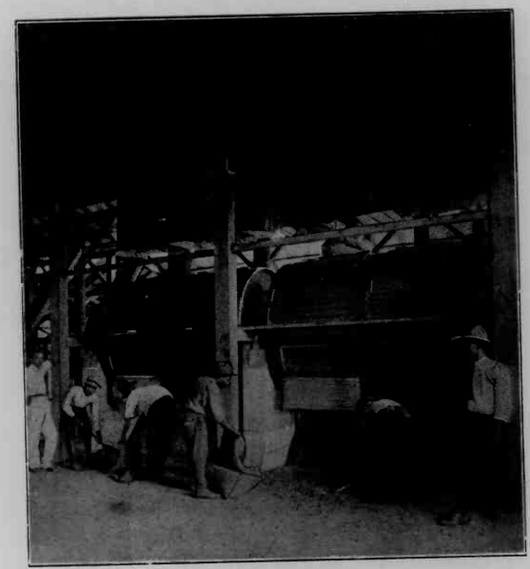

FIG. 15. ROTARY DRYING MACHINE (RIO HONDO, COSTA RICA)

(Made by John Gordon & Co., Old Broad Street, London)

have constructed special cars to bring the wet beans by rail from the plantation to a central plant. The wet beans are discharged from the cars direct into concrete vats from which they are conveyed by an elevator to the uppermost of a descending series of three fermenting bins. When fully fermented they are shovelled on to a conveyor which elevates them to a large number of Gordon rotary driers, in which they

INTENTIONAL SECOND EXPOSURE

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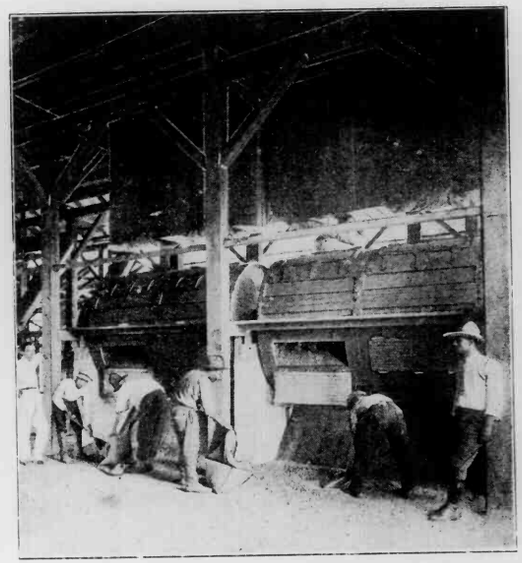

Fig. 15. Rotary Drying Machine (Rio Hondo, Costa Rica)
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are dried by being warmed by hot air to 120° F. for about 36 hours.

Loss on Fermentation and Drying. This is a matter of great importance to the planter who naturally wishes to obtain the highest possible yield of sound cacao.

The following figures, compiled from a paper by J. de Verteuil (in the *Proceedings of the Trinidad Agricultural Society* for August, 1922), will repay study from the economic standpoint—

LOSS ON FERMENTATION AND DRYING

Season	Fermented. Days	Per cent Loss	Dried. Days	Per cent Loss	Total Loss
Dry	1½	6·3	9	50·7	57·0
Wet		7·2		50·1	57·3
Dry	3½	8·9	7	46·1	55·0
Wet		10·9		46·8	57·7
Dry	5½	13·7	6	41·3	55·0
Wet		16·1		41·4	57·5

It will be noted that the loss is higher in the wet season, and that cacao fermented for the shorter period requires a longer period of drying, and as drying requires large areas it is generally the " bottle-neck " in cacao production on estates. Had these experiments been carried a little further they might have definitely determined the most profitable period of fermentation for Trinidad cacao. The usual period of fermentation in Trinidad is about eight days, and then the total loss varies from 62 to 67 per cent. Similar losses have been recorded by Hudson in St. Lucia, and by Van Hall in Surinam. The average yield from 100 parts of Forastero cacao, from the pod, may be taken as 36 parts of cacao beans of commerce. Hudson has shown that if the beans are not fermented at all, but merely dried, that the average yield is 39 per cent, that is 3 per cent by weight more than in the case of fully fermented

cacao. In spite of this higher yield, fermentation is profitable because its use does not increase the total cost of production (one is compensated for the trouble of fermenting by the shorter period of drying) and the fermented cacao always fetches a higher price.

Improving the Appearance of the Bean ; Washing, Claying, etc. In different countries various operations are carried out chiefly with a view to pleasing the eye of the buyer. Other advantages are claimed for these processes, but the claims have not, in the author's opinion, been substantiated. These processes consist of washing, claying, dancing, and polishing.

Washing is practised in Ceylon and Java. The beans are well washed before drying to remove the last traces of pulp. The planter suffers a loss on the weight of his cacao of about 6 per cent, and obtains beans, the shells of which have an even red-brown colour, which is very attractive. Some of the loss must occur from the inner part of the bean, for the actual difference in shell percentage between washed and unwashed is about 3 to 4 per cent, and as a result buyers will only give 3 or 4 per cent more for washed cacao. It is clear, therefore, that washing is unprofitable to the planter. It is also unprofitable to the manufacturer as washed cacao does not stand handling or storage as well as unwashed. The presence of a little pulp toughens the shell and prevents it breaking. On washed beans the shell is almost as thin and brittle as a dry leaf, and on handling easily breaks, so that some bags contain much debris on arrival at the factory. A further disadvantage is that this breakage allows insects or mould to gain entry to the beans.

In Venezuela, where fine cacao is grown, the curious process of claying is indulged in. It was until recently the custom in Trinidad also. A ferruginous clay, which readily dries to a rich red powder, is sprinkled on the beans before they are quite dry. On Venezuelan beans

the earthy coating is thick and the added earth is from 2 to 3 per cent of the weight of the bean. In Trinidad the natives used literally to dance on the clayed beans, whereby the amount of clay was reduced to about 1 per cent, which adhered tightly to the shell, and the beans assumed an even, smooth, and red appearance. Claying is said to assist the planter in drying his cacao, but from the chocolate manufacturers' point of view it has no advantage. The presence of clay was once the hall-mark of certain plantations producing fine cacao. Now that this significance is lost, the process of claying has nothing to recommend it. It gives the cacao a uniform appearance which is pleasing to look at, but there is no evidence that it produces any beneficial effects. The clay is said to act as a preservative; it does not, however, under severe conditions, prevent the cacao going mouldy. It may be of some assistance in preventing the cacao becoming grubby, but cacao which is not clayed (e.g. Grenada) is as free from grubs. There is no evidence that it preserves the aroma. To the buyer it has two objectionable features, one is, that by claying, inferior cacao can be given the external appearance of good cacao. Thus, taking an extreme case, black cacao from diseased pods, when well clayed, may sometimes be mixed with good cacao. The second objection is that the buyer pays for cacao and obtains clay, the amount on good class cacaos varying from 0·5 to 2·0 per cent. In 1923, at the request of the planters, a law was introduced in Trinidad making the use of clay or kindred substances illegal. In spite of these facts, such is the effect of tradition, that some buyers still prefer clayed Venezuelan cacao and pay extra for it.

A smooth appearance adds nothing to the intrinsic value of the beans, but it suggests careful preparation, and, hence, predisposes the buyer to a favourable opinion. A slight gloss can be obtained by " dancing,"

but on large estates it is more efficiently accomplished by a Barnard's Patent Cacao Polisher, or by the machine invented by Mr. Malins-Smith of Grenada.

Whilst on the drying platform the beans are picked over, and it is usual to get a wastage of from 4 to 6 per cent which consists of broken fragments of beans and dust. This material is usually sold locally On a few estates the cacao is graded by sieving.

Labour Required. The author remarked in an earlier chapter that, since 500,000,000 cacao trees are needed to produce the cacao crop of the world, a vast number of people must be employed in its cultivation. The number so employed is certainly very great on the Gold Coast and in Nigeria, partly because in these places the whole of the family assist in working the plantation. On the Gold Coast alone, whilst the number of plantation owners is 150,000, the total number of men, women, and children occupied in cacao production is in the region of one million. When the output is divided amongst the able-bodied men in the industry, the production figure obtained is 16 cwt. for each man per annum. On the Gold Coast the natives own and work the plantations and there is not the same economizing in labour as occurs in countries where the plantations are owned by Europeans. In this connection, let us consider Ecuador as a contrast to the Gold Coast. In Ecuador the estates are worked with the very minimum of labour, and on a large estate there is only one labourer to every 7,000 trees, or one labourer to every 8,000 lb. (71 cwt.) of cacao produced per annum. It is unlikely that the plantations are worked with the same economy of labour in other countries as in Ecuador, but even if they were, for an estimation of the total number of people engaged in the world's cacao production, we must add to the million or more in West Africa, at least 40,000 employed in the remaining cacao-producing countries.

Before passing on to consider how the cacao is marketed, the author proposes to discuss the production of cacao on the Gold Coast. This is such a momentous matter that it will be given a chapter to itself.

CHAPTER VII

THE GOLD COAST—THE MOST IMPORTANT CACAO-PRODUCING COUNTRY IN THE EMPIRE AND THE WORLD

THE dictum that there is nothing new under the sun must be set aside, or the Gold Coast cacao industry cited as an exception. There is surely no record in the history of the world of such rapid development in a native-owned industry. It was a cultivation, be it noted, with which the natives were totally unfamiliar. In 1878 there was not a single cacao tree on the Gold Coast; now there must be 100,000,000. A blacksmith, by name Tette Kwesi, brought the first pods to the Gold Coast in 1879. Optimistic experimenter as he must have been, he could never have imagined when he brought those cacao pods from Fernando Po and planted a few seeds in his garden patch at Mampong, that the planting of cacao on the Gold Coast would spread almost with the rapidity of a bush fire. Yet four years later, in addition to pleasure at the result of his foresight, he may have felt prophetic tremors when he sold his harvest to other natives at £1 a pod.

In 1891 the Gold Coast exported 80 lbs. of cacao; in 1926 the magnificent quantity of 504,000,000 lbs. How did this great development happen without European management and without European capital? It is true that in the early days Sir William Griffith, the then Governor, encouraged the industry, and that he was ably helped by the missionaries of the Basel Mission. It is true that in British West Africa, as in no other dependency, the Governors, notably Sir F. Gordon Guggisberg, have steadfastly upheld the native land rights. It is true that the climate and soil were "just right," and that a fatherly agricultural department

has given many seeds and much instruction to the natives. It may be that the imitative natives noted the pioneer efforts in cacao planting of a handful of Europeans, of which those of Mr. W. F. Hutchison in 1885 and Mr. J. H. Batty in 1888 were the earliest. If we allow these advantages, it still remains a modern miracle—a lesson both to statesmen and economists (the reader will note the distinction). Cacao has had a great civilizing influence. The natives were wanderers, in part warlike—notably that tribe of warriors, the Ashantis—practising a very primitive form of agriculture, clearing the bush, growing foodstuffs, and then passing on to clear fresh bush and make gardens anew. They settled down to cacao-growing, became a small nation of peasant proprietors, and after thirty years' effort have, as far as quantity of output is concerned, outpaced all other countries and left them panting in the rear. They promise to produce half the cacao in the world. Indeed, it is said they do produce more than this quantity now, but the cost of carrying it to the port is such that only a portion of the crop is exported. This is a difficulty with which they have always had to contend—they have had to get their cacao to the ports entirely without the assistance of pack animals, for these cannot live because of the deadly tsetse fly, and a large part of the energy of the people was, and is, absorbed in porterage. This misdirection of energy has been greatly reduced by the enterprise of the Government in building railways and making a network of roads suitable for motor traffic. By 1926 there were 495 miles of railways and 3,434 miles of passable motor roads

The quantity of the cacao produced is enormous, but what of the quality? It is true that the bean of the Amelonado variety of Forastero, as grown on the Gold Coast, lacks any special character, but the tree has the advantage of being hardy and capable of yielding

FIG. 16. FORESHORE AT ACCRA, WITH BAGS OF CACAO READY FOR SHIPMENT

INTENTIONAL SECOND EXPOSURE

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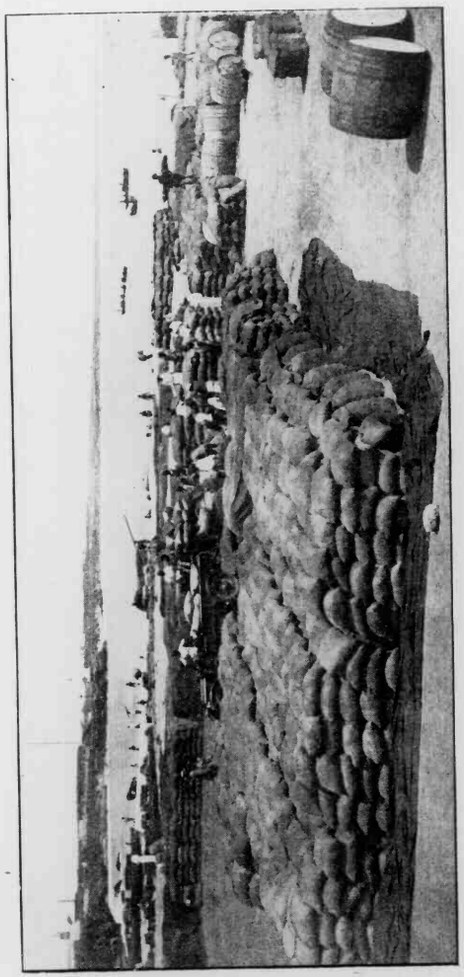

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heavy crops, as much as 5 lb. a tree, given sound cultivation. The cacao of the Gold Coast had, at one time, a bad name for quality, even as the climate had for unhealthiness. Neither cacao nor climate deserves this to-day. It would be unreasonable to expect that in a single generation the natives should learn and practise the whole art of cacao production. With the encouragement and help of the agricultural department great improvements have been made. Fermenting and drying now receive considerable attention, and the practice of fermenting for *six* days in heaps, baskets, or " odum " boxes continues to increase. The farmers have yet to adopt the practice of thorough turning of the fermenting cacao once a day. Not only have there been improvements in the preparation of the beans, but more recently there have been signs that care is being taken in the cultivation of the tree. Knives are now generally used for harvesting the pods, and attempts are made in some places to keep the plantations clean. Some of the intelligent natives see the folly of crowded seed beds and crowded plantations, and realize that the planting of trees 6 ft. to 10 ft. apart, as in the past, was an error.

People sometimes talk as though the whole output of the Gold Coast was very inferior stuff; this is absurd. Although the care in preparation leaves much to be desired, there are probably at least 60,000 tons of good, sound, fermented cacao produced every year. This is more than any other country can boast of. Even if we take the bulk, it is far better fermented than the cacao of Para, or, amazing as it sounds, than the cacao of Ecuador.

It is partly on account of its lack of uniformity, and its mixed and uncertain character, that the cacao fetches a low price. Happily, it is produced more cheaply than any other cacao. As Sir Hugh Clifford has expressed it, " there are no charges to pay on account of costly

European supervision; no directors' fees and office expenses on the Gold Coast or in London; no dividends to pay upon borrowed capital." In spite of the increasing cost of labour, the Gold Coast remains a very dangerous competitor to the other cacao-growing countries.

The Gold Coast keeps easily first in the race—is there any obstacle in its path which may trip it and send it headlong? It may be remarked that an industry so rapidly built up naturally lacks the solid security of those that have been established for a century or more. Wherein lies its insecurity? Chiefly in this—that, owing to the excessive clearing of the forests and the lack of anything approaching scientific cultivation, the cacao tree may cease to thrive.

The effect of forests on climate is well known. Over a century ago Von Humboldt expressed the opinion that the cacao of Caracas (Venezuela) was no longer so good as it was originally, because the country had become denuded of trees and hence was dryer and more exposed to winds. The effect of " shifting cultivation " with its reckless felling of forests in a country like the Gold Coast, which has already probably the lowest rainfall of all cacao-producing countries, will no doubt be disastrous if persisted in. It is to be hoped that the Agricultural Department will be listened to and their advice followed, for it is contended by experts that, unless 25 per cent of the land remains covered with forest, the climate will become too dry for cacao.

The absolute dependence of the Gold Coast on cacao makes the further question, how the plantations will fare in the battle with disease and pest, one of great importance. That in the past the natives have generally taken no care in seed selection and have ignored the most elementary principles of agriculture, such as drainage and keeping the plantations clean, is well known. One is justified in the fear that, just as in the

Middle Ages, in spite of the wise teaching of the few, because of ignorance and insanitary conditions, the whole population of a city was sometimes wiped out by a plague, so the millions of cacao trees on the Gold Coast may suffer a slower, but equally sure, destruction. In the past, however, because fresh areas continually came into bearing, the output has increased by leaps and bounds. On the one hand, we have the experts trembling and crying, "Wolf!"; on the other, the mass of illiterate natives lacking in foresight and blind to a thousand dangers. The natives appear to regard pests and diseases as being caused by evil spirits, and, as charms cannot be obtained to remove the evil, they are resigned to it, and abandon the plantations so infected. Although a few plantations have recovered when thus abandoned and neglected, there are obviously the very gravest risks that this procedure will spread infection. There are optimists who put their faith in nature, believing it has a bias in favour of healthy trees; and if nature fails, they trust that the breaks, due to forest growth between the areas planted, will prevent infection spreading. Neither faith nor benevolent feelings will prevent the increase of disease if applied knowledge is lacking. Ask the planters in countries where cacao has been grown for a century or more. Plantations, as they know well, are not saved by good intentions.

The value of the cacao crop in the Gold Coast for 1927 and 1928 was over eleven millions sterling a year. It may be remembered that the coffee crop in Ceylon once had an annual value of three million pounds; in a few years the crop was reduced by 99 per cent, and the industry ruined, owing to the coffee leaf disease.

Before 1910 one heard little of diseases and pests on the Coast; to-day the list of those that are troublesome is a long one. Heavy annual losses occur chiefly through the "Black pod" disease, and the attacks of

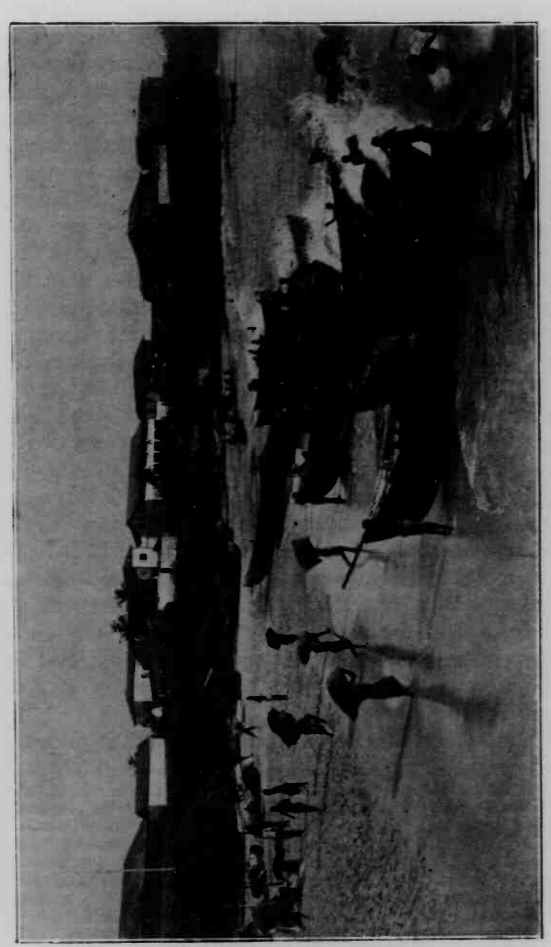

FIG. 17. CARRIERS CONVEYING BAGS OF CACAO TO SURF BOATS, ACCRA
(Reproduced by permission of the Editor of *West Africa*)

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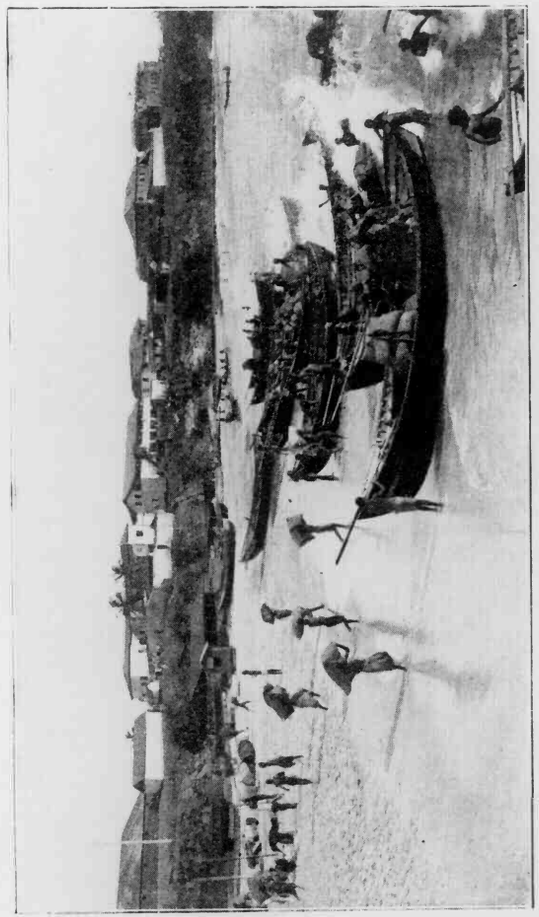

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a bug on the stems of the cacao.[1] There have, however, as yet been no epidemics, and one knows that everything that can be done in an advisory capacity is being done by the energetic Department of Agriculture and its provincial staff. Their hands have been strengthened by the Plants (Injurious Pests) Ordinance. The publications of both the department and the late Gold Coast Agricultural and Commercial Society (1921–28), show how the intelligent and educated representatives of all classes are alive to the dangers, and it is generally felt that, given sufficient encouragement by prices graduated according to quality, and by the merchants' refusal of any cacao of inferior grade, not only the standard of cultivation, but also the standard of preparation for the market will continue to rise. The European merchants have played a valuable part in the past in the development of this industry, and are a determining factor in its standing in the future. It is to be feared that not all European and American buyers appreciate their responsibilities in this direction. However, as Sir Hugh Clifford said in 1919, " One or two firms it is true, of which Messrs. Cadbury Bros. and Messrs. Pickering & Berthoud are the principal examples, have consistently refused to buy cacao which is not of approved quality, and the adoption of this policy has been productive of good results."

The natural flow of economic conditions is generally

[1] Of diseases due to microscopic fungi, " Brown pod " or " Black pod " (*Phytophthora*) is the most widespread. Thread blight (*Marasmius scandens*, Massee) and " Die back " (*Diplodia cacaoicola*) are also known. It is curious to read that a kind of Mistletoe (*Loranthus*) causes serious trouble. Of insect enemies, the " Stem Sappers " (*Sahlbergella singularis*, Hagl., and *S. Theobroma*, Distant) are well known for their destructive effects. The natives call them " Sankonuabe," which signifies: give up cacao and " go back and pluck palm nuts." The " Cocoa mosquito " (*Helopeltis Bergrothi*) is also a serious pest. The presence of various borers, the Glenea borer beetle and more rarely *Armatosterua baquetiana* and *Characoma stictigrapta*, Hamps., have also been observed, as well as Thrips and the Megalopygid moth (*Eulophonotus myrmeleon*).

preferable to Government intervention, but, if the majority of the buyers do not adopt the above principles, it is unlikely that the quality of the cacao will automatically improve. Inspection of cacao at the ports of shipment was commenced in 1927, and valuable information has been obtained on which to found methods for raising the standard. An advance has also been made in another direction which is equally promising, namely, the successful operating of a co-operative unit for preparing and marketing cacao.

There is no space here to deal with the difficulties of finance or currency, or with the dangers that beset a community which depends so much on a single natural product. For a delightful chat about the industry on the Gold Coast one should read Miss E. A. Browne's book on *Cocoa*. An authoritative statement of the position up to 1919 is W. S. D. Tudhope's *Enquiry into the Gold Coast Cocoa Industry*. Since 1924, the Department of Agriculture has published a *Year Book* and a number of *Bulletins* which bring the reader up to date and contain much valuable scientific information.

CHAPTER VIII

COLLECTION, TRANSPORT, AND MARKETING OF CACAO

Bagging. The planter weighs his cacao into good strong jute bags. This is now the universal method of packing: the "Socunusco" cacao from Guatemala used to be exported in buffalo-hide bags and cacao from Madagascar in cowhide packages stitched with leather thongs, but these belong to the picturesque past. A suitable sack to hold 1¼ cwt. should be made of sufficiently stout material to weigh at least 2½ lb., as it has to bear rough handling. The bags are carefully sewn up and stencilled or marked in a characteristic way which is generally indicative of the estate on which the cacao was grown.

One frequently sees in cacao statistics the amounts indicated as so many bags. This cannot signify a definite quantity unless the country of origin is known, as, unfortunately, the recognized weight varies from country to country. The following examples illustrate this—

APPROXIMATE WEIGHT OF BAGS OF CACAO

Country of Origin	Customary Tare Allowance	Net Weight of Cacao in Bag
	lb.	lb.
Trinidad	4	196
Grenada	3	196
Jamaica	3	196
San Domingo	3	196
Guayaquil	Net weight	175
Surinam	3	168
Gold Coast	2½	140
San Thomé	2½	132
Bahia	Net weight	132
Venezuela	4	112
Ceylon	2	112

Transport to the Shore. The conveying of cacao to the point of embarkation is a subject on which it is difficult to generalize, as will be seen by a brief consideration of the methods of five important producing countries, the Gold Coast, Brazil, Ecuador, Trinidad, and San Thomé. In the more remote parts of the Gold Coast the primitive method of head loads is still

FIG. 18. OLD METHOD OF TRANSPORT BY HEAD LOADS, GOLD COAST

used to convey the cacao to road or rail. The usual head load is 60 lb., but the native easily carries a 140-lb. bag of cacao for many miles. The noisy and picturesque use of the palm-oil barrel for the transport of larger quantities, once so common, is now rapidly becoming a curiosity; occasionally, however, one may still see half a ton of cacao in a huge barrel being trundled by two or three men down the ways to the coast. In the last few years head-porterage and barrel-rolling have been largely displaced on the Gold Coast by the use of motor vehicles, which already in 1922 numbered 2,000 in Kumasi and 4,000 in Accra. The effect of

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these motor lorries and the railways, in increasing the area over which it is economic to gather cacao, may be calculated from the following list of transport rates per ton-mile: by head load, 6s. od.; by motor lorry, 2s. 9d.; by railway, 1s. od.

In Brazil, in the State of Para, the problem of transport is complicated by the liability of the vast region

FIG. 19. TRUNDLING BARRELS OF CACAO DOWN TO ACCRA

round the Amazon to inundation when this mighty river is in flood, and much of the cacao is brought down the waterways in canoes. In Ecuador, barges, motor launches, and rafts are used for the same purpose. "One may see sixty rafts fastened together, three abreast, with a family hut built upon the central point and a couple of men poling downstream, while a few others attend to the cacao beans drying on waterproof sheets in the sun."[1] The progress in Brazil in the State

[1] *The Confectioners' Union*, p. 2803 (1920).

of Bahia illustrates the value and importance of efficient transport: the great increase in the output of the Ilheos district—the production has doubled in twelve years—would not have occurred but for the facilities offered by the South Western Railway for bringing the crop from the inland plantations down to the port. In Trinidad one sees the more commonplace use of mules and vehicles for conveying the cacao to the nearest railway station. San Thomé is advanced in the matter of transport, light railways running right into the plantations. In most places the roads are so graded that all the full trucks gravitate to the sweat boxes. There are few countries which would not profit by the adoption of methods similar to those used in San Thomé.

Shipping Cacao. Preferably cacao should not be stored in the tropics but shipped as rapidly as possible. In a moist hot climate it is liable to become mouldy, especially if imperfectly dried, and also to be attacked by such cosmopolitan pests of stored foodstuffs as the Mediterranean Flour Moth (*Ephestia kühniella*), *Ephestia elutella*, and certain tiny beetles (*Araeocerus fasciculatus*, etc.).[1]

As affecting the quality of the cacao, the method of conveying it from the port to the ocean liner is more important than the transporting to the shore, because there is greater risk of getting the cacao wet. Good harbours in the tropics are few, and the cacao generally has to be taken out in lighters to the ocean liner which stands off from the shore. The Gold Coast had no deep sea harbour until the great breakwater, nearly a mile and a half in length, was built at Takoradi, near Secondee, at a cost of over three millions sterling. This

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harbour is of special advantage to the Gold Coast because of the heavy surf which beats upon the shore, and which formerly necessitated conveying everything, including cacao, out to the Elder Dempster steamships in surf boats. The use of the harbour accelerates the handling of cargoes, and should reduce demurrage and the loss through damage.

The leading shipping ports of the world for cacao are Accra and Takoradi, both on the Gold Coast. Until 1928, Secondee was not only the port of shipment for the cacao grown in Ashanti, which is responsible for nearly one-third of the total output of the Gold Coast, but also for other districts, and shipped in all about 40 per cent of the Gold Coast cacao. Presumably, with the extra facilities which Takoradi offers, it will in the future ship all this and more. The principal shipping port for Brazil is Bahia, which exports nearly ten times the quantity shipped from the other leading port, Para. About 95 per cent of the cacao of Ecuador is exported from Guayaquil. Port-of-Spain is the chief port for Trinidad, Lagos for Nigeria, San Thomé for San Thomé, and Sanchez for the Dominican Republic; while Venezuela ships chiefly from La Guayra, Carupano, and Puerto Cabello.

Several manufacturers, Menier, Suchard, Cadbury, Terry, and others, have estates of their own, but these estates produce only a small part of their requirements. Manufacturers seldom deal direct with the planter, although in some cases they have their buying agencies on the spot. Planters either sell locally or ship direct to European brokers. Most of the buying in England is done on cost and freight contracts. In this case the weight of the bags is deducted by the seller, and the buyer takes all other charges, including shrinkage up to 2 per cent. More rarely the cacao is sold on London or Liverpool landed terms, in which case the planter, in calculating his returns, has to

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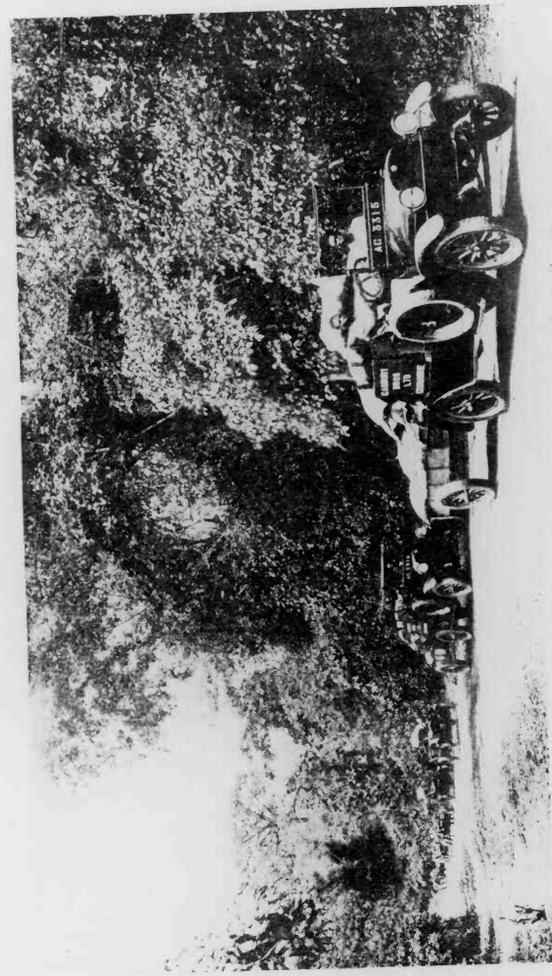

FIG. 20. MODERN TRANSPORT OF CACAO ON THE GOLD COAST

subtract from the gross weight not only the tare, but also the amounts allowed for sampling and for loss in weight. He then has to deduct from the market value of the remainder, the insurance, freight, dock and landing charges, and the agent's commission.

Co-operative organizations of cacao producers have been formed in Trinidad, Bahia, and other places, and valorization schemes have often been proposed in connection with cacao. The Trinidad Planters' Association is in a flourishing condition, and in 1928–29 handled 58,182 bags of cacao. In Ecuador in 1912 the *Asociacion de Agricultores del Ecuador* was formed in the interests of the planters and exporters, for the express purpose of storing and holding up cacao when prices were low. Such efforts tend to stabilize industry, but the fact mentioned above, namely, that cacao deteriorates if stored in the tropics, is a serious objection from the manufacturers' and consumers' points of view to the application of such schemes to cacao. And in this case it is by no means certain that the scheme worked out profitably for the planters, for about 1920–21, the *Asociacion*, presumably because it held up cacao on a falling market, was in financial difficulties, and during 1920 increased its tax on all cacao exported from 2s. 6d. to 7s. 6d. for each 100 lb. Despite this effort, however, the *Asociacion* has ceased to function.

The Sale of Cacao. The principal cacao markets of the world are New York, Hamburg, London, Liverpool, and Hâvre. Other cacao markets are Bordeaux, Lisbon (to which the San Thomé cacao is shipped), and Amsterdam (where Java cacao is handled). During the war Hamburg lost its position as the largest cacao market, and by 1929 had not regained it. The New York Cocoa Exchange is now the most important factor in the marketing of the world's cacao supply, and the volume of business transacted is now more than

the combined volume of business of all other cacao markets. A great part of the Gold Coast crop goes to Liverpool, and London and Liverpool together form a greater market than Hamburg. In 1929 the Cocoa Association of London, Ltd., was formed with the object of regulating the London cocoa trade, improving and increasing production and extending consumption. London has one little advantage over all the other markets: it holds a public auction, and although sometimes only small quantities are sold, the prices at which the cacao changes hands are wired all over the world and form a basis for negotiation. This applies particularly to West Indian cacao. It used to be said that, what Greenwich observatory is to the users of clocks, the London sale is to the sellers of cacao, but the sale has lost its former importance and is no longer held regularly once a week. The auction is well over a century old, and in the early days the conclusion of the bidding was decided "by the candle." The auction is conducted in the Commercial Sale Rooms in Mincing Lane on Tuesday at 11 o'clock. The sale room is not very impressive; it resembles a large lecture theatre. But commerce of this character has so long been associated with Mincing Lane that the place has for the visitor an atmosphere of romance. One is silent in awe, contemplating in thought the succession of experts in tropical produce who have bought and sold within those walls. Peering down the corridors of time one hears the murmur of those who have made and lost fortunes through the rise and fall in the prices of strange raw products that half the world has never seen. How many drinkers of cocoa could describe a cacao bean? It is about the size of an almond, though plumper and less pointed. The number to the lb. vary from 300 for Arriba to 450 for Grenada cacao, and average about 400. The skin or shell is brown. Under the shell at the broader end is the germ or radicle,

which is hard, rod-shaped, and about one-fifth of an inch long. The inside (the cotyledons) of the bean may be milk-chocolate colour, brown, dark-brown, purple, or slate. The taste is fatty, more or less bitter and astringent, nutty and faintly aromatic. The odour of the raw bean is quite unlike chocolate; it is peculiar to raw cacao and contains a vinegary component. Not a single bean is to be seen at the auction. However learned the babble of the sale room may be, the auctioneer does no varnishing; he merely puts up the lots under a brief and accurate description. It is possible, however, to obtain samples before the day of sale, and these are always on show in trays at the various brokers' offices on the previous day. It is usual for prospective buyers to see these samples before going to the sale and to make notes on their lists against the various lots offered.

The cacao bought and sold may run into many thousands of bags, but it is only a small quantity compared with that which is sold by private contract for forward delivery, and an increasing amount of cacao is now bought, not according to sample, but according to type or specification. The public auction is of interest, not on account of the quantities sold, but because it gives periodically to the cacao world a definite indication of the trend of prices.

The Price of Cacao. Only for one brief year in its history has the price of cacao ever remained constant. This was during 1918 when the Food Controller fixed the price of the best qualities of the different varieties of raw cacao. The list shown on page 97 gives one an excellent general idea of the way cacaos are graded.

On page 98 will be found a diagram showing the variation in price of four important varieties of cacao, one from each of the four sections, during the years 1913 to 1928. The most notable feature is the manner in which prices rose in 1919 like a rocket, when the

Government control was taken off, and then fell like the stick in 1920. This fall in prices was a great loss to all holders of stock, and in one or two instances the losses were so great as to cause disaster.

Valuing Cacao. As far as country of origin is concerned, there is, to the uninitiated, something freakish in the great variation in price paid for beans which look so similar, and it is not possible, with the more expensive kinds, even for the expert entirely to account for it. However, apart from the effect of freight on price, one can call attention to certain qualities which influence price and which are little affected by the vagaries of fashion or the vicissitudes of taste. In the first place, cacao of the Criollo type which shows, on breaking the bean, a cinnamon-coloured fracture (such as one sees in the better grades from Ceylon, Java, Venezuela, Samoa, Madagascar) has always been considered the finest cacao. Connoisseurs of chocolate have pointed out with regret that the delicate Criollo type is slowly dying out and giving place to the hardier Forastero, which has a dark-brown or brownish-purple "break." It may be well here to clear up a possible misconception. Criollo beans are born, not made. That

FIXED PRICE OF CACAO

APRIL, 1918, TO MAY, 1919

British West Africa (Accra)	65s. per cwt.
Bahia, Cameroons, San Thomé, Congo, Grenada	85s. „ „
Trinidad, Demerara, Guayaquil, Surinam	90s. „ „
Ceylon, Java, Samoa	100s. „ „

These figures do not include the import duty, which at that time was 42s. per cwt.

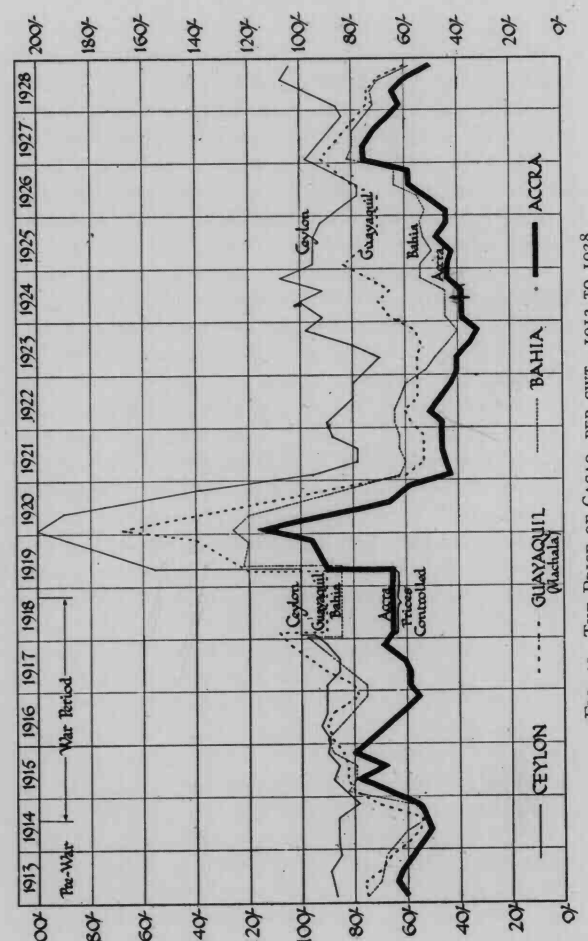

FIG. 21. THE PRICE OF CACAO, PER CWT., 1913 TO 1928
These prices do not include import duties

is to say, they are born white as ivory and become cinnamon brown on proper fermentation and drying. Forastero and Calabacillo beans as they come from the pod are purple, and on correct fermentation and drying develop a more or less dark-brown colour. No amount of fermentation will ever give a Forastero bean the light-brown break of the Criollo. You cannot make damsons into greengages, but damsons are good to eat for all that. If Criollo is the queen of cacaos, Forastero and Calabacillo are the yeomen, and on their backs the industry rests.

Whether the cacao be Criollo or Forastero, the buyer prefers large, plump beans, the shell of which is crisp but not too brittle, and more or less loose from the interior. On squeezing a handful of good beans a light crackling is heard, and under firm pressure the bean breaks into small crisp fragments. The colour of the fracture depends on the kind of cacao, but whether the tint is cinnamon-brown, dark-brown, or brownish-purple, it should be a pure colour free from any suggestion of mud or slate-grey. A flat bean, a slate-coloured "break," the fragments leathery or cheesy in consistence, the shell soft and clinging closely to the bean, are as so many red lights warning the buyer of imperfect fermentation. The buyer naturally prefers an even cacao to a mixture, and notes such gross imperfections as germinated beans, mouldy beans, and grubby beans.

The method of procedure in judging a cacao is usually to glance first at its general external appearance, and make some such examination as is suggested above. The buyer then cuts a suitable number, say 100 beans, into halves and carefully examines these so as to get a percentage analysis. Their general character is noted and an estimation made of the good, unfermented, and defectives. Some buyers are satisfied with this, but the more thorough proceed to roast the bean and test the aroma and other properties of the roasted product. The old proverb says, "The buyer has need of a hundred

eyes." In the case of cacao he needs also at least one nose, and that a trained one. He pays great attention to the odour and the slightest alien tang, whether described as "hammy," mouldy, musty, smoky, or cheesy, is generally sufficient to condemn the sample. As far as the author knows it is exceptional to go further and to take the butter percentage and the shell percentage into account in valuing a particular sample, although a knowledge of the usual composition of the type may influence the buyer.

In fixing a price for a cacao one must also consider the demand, and this is definitely determined by the manufacturers' recipes. It is obvious that every cacao produces its own peculiar characteristics in the cocoa or chocolate prepared from it, but only the manufacturer knows exactly the qualities he is striving to produce in his finished goods, and what cacao, or blend of cacaos, will give the desired result. His aim is to please the public, and thus the taste of the public is the ultimate arbiter of value. The modern manufacturer aims at producing an absolutely standard product in large quantities for sale at a reasonable price—hence the tendency to use those not too expensive cacaos of which a large, reliable, and regular supply is available. A writer in the *Times Trade Supplement* (15th July, 1922) says, "As a rule it is customary to use a background of more than half of the mixture of some cacao of a not too pronounced variety. For this purpose the West African cacaos are used most extensively. A little higher up in the scale of strength come Bahia and San Thomé cacaos. Venezuelan cacaos vary from the cheapest to the best varieties; Ceylon cacao is high grade and is favoured in this market, but the two types which are most in demand for 'lifting' the chocolate mixture and determining its flavour are Trinidad and Grenada. Guayaquil has been used for making drinking cocoa, without blending, with considerable success."

CHAPTER IX

THE COST OF CACAO PRODUCTION

THE cost of cacao production has in the past been somewhat neglected in most books on cacao cultivation. Some up-to-date figures are given in W. A. MacLaren's *Rubber, Tea, and Cacao* (1924), and C. Y. Shephard has, under the title of an "Economic Survey of the Cacao Industry in Trinidad" (in *Economic Geography*, 1927), made an important contribution to the subject. It is proposed here merely to give the figures for two estates in some detail, and Ceylon and Trinidad have been chosen as illustrating costs in producing areas where sound methods of culture are practised. It is appreciated that such figures may not have a wide significance, but until the expert agricultural economist presents us with a résumé of the costs of cacao planting derived from a wide experience of a variety of plantations, these figures expressing the results of localized experience will be of interest to the student and the young planter. The author is indebted to Mr. E. W. Keith of the Kondesalle Estate, Kandy, Ceylon, for working out for inclusion in this book—

1. The costs of opening up and keeping up an estate in Ceylon for the first five years, that is, until the trees begin to bear.

2. A capital and revenue account showing the first five years of bearing.

3. The cost of producing 1 cwt. of cacao on an estate in full bearing, the yield of which is 5 cwt. per acre.

The whole drama of cacao production is brought into the limelight by these figures, and, although they apply specifically to Ceylon, where the cacao bean is of a very fine kind, and the methods of cultivation the most advanced and thorough, they illustrate the costs of

the various items, a number of which must be borne wherever an attempt is made at cacao cultivation.

Many estates in Trinidad have been established by the contract system. By this method the land is let out to the contractor for four or five years, during which period he has the privilege of growing certain kinds of provisions on the land rent free, and at the end of that time the young cacao trees are bought from him at 8d. to 1s. a tree. The costs below are for those cases in which the planter takes charge. The author owes the figures to the kindness of Mr. Stanhope Lovell. The cultivation is not quite so elaborate as in Ceylon, but any reduction due to this is compensated for by the very high cost of labour, the conditions of which, as in many other parts of the world, are not so settled as formerly. For many years indentured East Indians formed an important part of the available labour, and the recent termination of indentured immigration has produced a shortage.

Cost of Starting a Plantation. Mr. Stanhope Lovell's figures throughout were for 1922. Had the figures been given for 1923, 1924, or 1925 they would not have been materially different. They would apply to a plantation of, say, 200 acres, where the ground was level and the soil calcareous. The costs do not include either the expenses of management or the costs of stock or buildings—

COST OF STARTING A PLANTATION IN TRINIDAD

	Each Acre Costs: £ s. d.	£ s. d.
Felling and clearing	3 – –	
Drainage, roads, weeding, etc.	4 – –	
Planting	2 – –	
		9 – –
1st year		2 10 –
2nd year		2 10 –
3rd year		2 10 –
4th year		2 – –
5th year		2 – –
6th year		
Total cost to bring to bearing		£20 10 –

It is interesting to compare this with the figures given by Hart in pre-war days. He writes: " It is calculated that an estate can be established by the contract system at a cost of about £12 to £15 per acre, exclusive of buildings." On the Gold Coast, the Omanhene of Akwapim estimated (1919) that the cost of bringing an acre into bearing was £6 for the first year, and £2 5s. a year for four more years, making a total of £15 an acre.

While the figures given on page 102 enable one to get an accurate outline of the costs, Mr. Keith's figures for Ceylon, in 1922, fill in the details. The costs were given in rupees, but that they may be more generally understood they have been converted into English money (100 rupees being taken as equivalent to £6 13s. 4d.). (See page 104.)

The list of expenses does not allow for any buildings, the cost of which would depend on their size and the acreage planted, or for the manager's salary. The capital cost, including salary and buildings, of an estate of 300 acres, would be about £26 13s. 4d. an acre.

These figures speak for themselves and give one a good idea of the relative importance of the different operations during the first five years on the plantation. When the ground is cleared the weeds spring up with lightning-like rapidity, and to check this, as thoroughly as is usual in Ceylon, requires much labour, especially in the first few years. Both Mr. Lovell's and Mr. Keith's figures show a high initial outlay on roads and drains, an outlay which cannot safely be scamped, for the former greatly facilitates the work on the plantation and the latter are essential to its health. It will be noted that manuring is an expensive item, especially in the third and fifth years. Every year a little has to be spent on " supplying " new cacao and shade trees to take the place of those which die or prove unsatisfactory from other causes.

PLANTING—FIRST YEAR

Each Acre Costs:

	£	s.	d.
Felling and clearing	1	–	–
Lining, holing, filling-in, and planting		13	4
Seeds and nurseries	1	–	–
Survey		1	4
Roads and drains	1	13	4
Weeding	2	–	–
Manager's commission for opening		13	4
Contingencies, medical aid, tools, etc.		8	8
Shading and shade trees		8	–
Estimated total expenditure	£7	18	–

BRINGING THE TREES INTO BEARING

Each Acre Costs:

	2nd year			3rd year			4th year			5th year		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Roads and drains		1	4		1	4		1	4		1	4
Weeding	1	12	–	1	4	–		16	–		12	–
Manager's commission		6	8		6	8		6	8		6	8
Forking round plants		2	8		—			—			—	
Forking with light application of manure		—		1	6	8		—			—	
Forking whole ground		—			—			5	4		—	
Manuring		—			—			—		2	–	–
Contingencies, medical aid, tools, etc.		1	4		1	4		8			8	
Shading and shade trees		1	4		1	4		8			8	
Supplying		1	4		1	4		8			—	
Terracing, boundaries, etc.		2	8		1	4		8			8	
	£2	9	4	£3	4	–	£1	12	–	£3	2	–

Total expenditure for the five years, £18 5s. 4d. an acre.

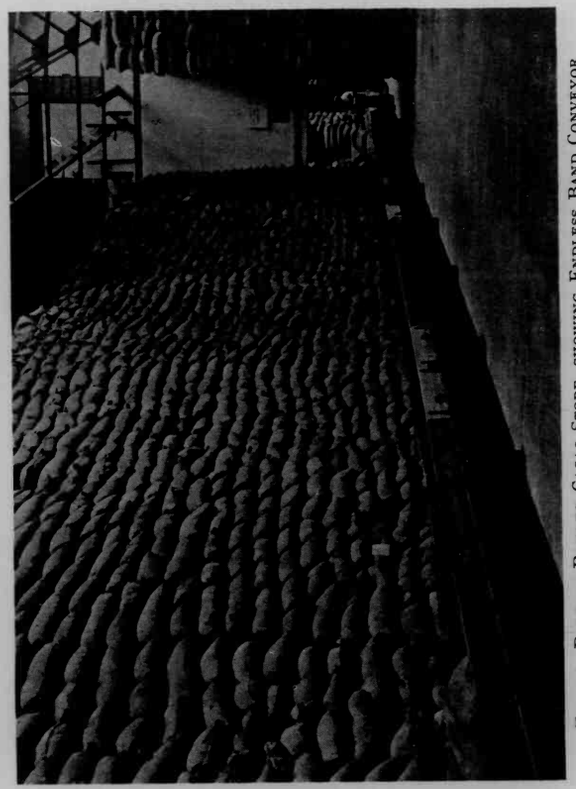

FIG. 22. PART OF BONDED CACAO STORE, SHOWING ENDLESS BAND CONVEYOR

INTENTIONAL SECOND EXPOSURE

PLANTING—FIRST YEAR

Each Acre Costs:

	£	s.	d.
Felling and clearing	1	—	—
Lining, holing, filling-in, and planting		13	4
Seeds and nurseries	1	—	—
Survey		1	4
Roads and drains	1	13	4
Weeding	2	—	—
Manager's commission for opening		13	4
Contingencies, medical aid, tools, etc.		8	8
Shading and shade trees		8	—
Estimated total expenditure	£7	18	—

BRINGING THE TREES INTO BEARING

Each Acre Costs:

	2nd year			3rd year			4th year			5th year		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Roads and drains		1	4		1	4		1	4		1	4
Weeding	1	12	—	1	4	—		16	—		12	—
Manager's commission		6	8		6	8		6	8		6	8
Forking round plants		2	8		—			—			—	
Forking with light application of manure		—		1	6	8		—			—	
Forking whole ground		—			—			5	4		—	
Manuring		—			—			—		2	—	—
Contingencies, medical aid, tools, etc.		1	4		1	4			8			8
Shading and shade trees		1	4		1	4			8			8
Supplying		1	4		1	4			8		—	
Terracing, boundaries, etc.		2	8		1	4			8			8
	£2	9	4	£3	4	—	£1	12	—	£3	2	—

Total expenditure for the five years, £18 5s. 4d. an acre.

FIG. 22. PART OF BONDED CACAO STORE, SHOWING ENDLESS BAND CONVEYOR

The expenditure in the initial year is £9 an acre in Trinidad and £7 18s. an acre in Ceylon. The first five years cost £18 10s. an acre in Trinidad and £18 5s. 4d. an acre in Ceylon.[1] All this money has to be invested before one begins to gather a single pod. As pointed out above, in the case of Trinidad, this expenditure does not include anything whatever for management. During the five or six years of waiting for the trees to come into bearing, the young planter would have to live and he could hardly do this on less than £200 a year. At least £1,000 must be added to the initial outlay. The increase which this makes on the cost of an acre naturally depends on the size of the estate.

When the cacao tree is five years old in Ceylon and six years old in Trinidad, it bears as follows—

YIELD OF CACAO BEANS TO THE ACRE

Year of Bearing	Trinidad	Ceylon[2]
	cwt.	cwt.
1st	1½	1½
2nd	2	2½
3rd	2½	3½
4th	3	4½
5th	3½	5
6th	4	5
7th	4½	5

If, as in Ceylon, the trees begin to bear after five years, the question now arises. how many years will the planter have to wait to get back the money he has

[1] Mr. Keith's figures for 1930 arrived too late to be incorporated, but the cost of the field work appears to have gone up over 50 per cent on the 1922 figures. Allowing for land purchase, superintendent's salary, construction of bungalow, drying and washing buildings, etc., the total cost in Ceylon of providing a fully-equipped plantation and bringing into bearing for this year (1930) is about £70 an acre.

[2] These yields are for the Forastero variety; Criollo usually yields less..

invested. According to Mr. Keith's figures, which are given below, after five years' bearing, sufficient cacao has been produced to give a profit equal in value to the capital expenditure, so that, ten years after planting, one's outlay is reimbursed. On Mr. Keith's figures the investment of £26 13s. 4d. after five years begins to yield £9 per annum.

ESTIMATED CAPITAL AND ANNUAL REVENUE
ON ONE ACRE OF CACAO, FOR FIVE YEARS IN BEARING

Capital	£ s. d.
To capital expenditure— Opening and bringing 1 acre of cacao into bearing	26 13 4
	£26 13 4

Revenue	£ s. d.
6th Year—1st year in bearing Yield 1½ cwts. an acre Cost of production at £2 2s. 8d. per cwt. Profit	1 10 –
7th Year—2nd year in bearing Yield 2½ cwt. an acre Cost of production at £1 16s. per cwt. Profit	3 6 8
8th Year—3rd year in bearing Yield 3½ cwts. an acre Cost of production at £1 12s. per cwt. Profit	5 7 4
9th Year—4th year in bearing Yield 4½ cwts. an acre Cost of production at £1 9s. 4d. per cwt. Profit	7 9 4
10th Year—5th year in bearing Yield 5 cwts. an acre Cost of production at £1 6s. 8d. per cwt. Profit	9 – –
	£26 13 4

In the above table the sale price of the cacao is taken as £3 2s. 8d. per cwt.

Cost of Producing One Cwt. of Cacao Beans (1922). Another interesting point is that, when the plantation is in full bearing, 1 cwt. costs about £1 7s. to produce and in 1922 sold for £3 2s. 8d. The table on page 108 shows in detail how the money is spent. In Ceylon, forking, pruning, and the lopping of shade trees are done every two years and manuring every three years, so the figures allow for forking, etc., over half the acreage, and manuring over one-third.

ESTIMATED COST OF PRODUCTION

Of each Cwt. of Cacao (Ceylon)

(On an estate of, say, 300 acres, in full bearing, giving a yield of about five cwts. an acre, and allowing for full programme of cultivation.)

	£	s.	d.	£	s.	d.
Salaries and General Expenses—						
Salaries		4	–			
Watchmen			5			
Contingencies			10			
Medical aid			6			
Labour recruiting			2½			
Allowances			2			
					6	1½
Cultivation—						
(*a*) *Cattle Establishment :*						
Cost and keep of stock		4	–			
Upkeep of grass fields (cutting grass)		1	4			
					5	4
(*b*) *Plantation :*						
Purchase of manure		3	4			
Application of manure			6½			
Cutlassing or weeding		1	2			
Diseases and pests (including rats, ants, squirrels, black cacao, etc.)		1	–			
Tools and carts			8			
Roads and drains			5			
Forking			4			
Pruning			3½			
Supplying cacao trees			2			
Shade trees and plants			2½			
Fences and boundaries			1			
					8	2½
Reaping and Preparation for the Market—						
Gathering and picking		1	2			
Curing, sorting and bagging			11			
Bags and matting (for drying)		1	–			
Transport (carting)			6			
Shipping			4			
Machinery and upkeep			2			
Export duty		2	3			
					6	4
Upkeep of Buildings, etc.—						
Barracks			6			
Cattle sheds			4			
Bungalows and furniture			2			
Factories			2			
					1	2
Total				£1	7	2

It will be noted that the most costly item is the practically indispensable cattle establishment. While some of the animals do useful work on the plantations, all provide manure of great value. In Trinidad, on an estate of 200 acres, one may find two horses, five mules, four cows, and two calves. All the items are self-explanatory with the exception of "Watchmen." Some planters regard watchmen as a necessary nuisance. Their chief duty is the prevention of theft, and other duties are sometimes added, such as the destruction of squirrels.

Costs vary with methods, and both alike are open to criticism. It may, therefore, be useful to give Mr. Stanhope Lovell's figures for comparison and contrast. These figures (see page 110) are for an estate of about 200 acres, yielding 4 cwt. to the acre, and the manager's salary is not included, neither is the cost of manure or barracks. It is well to note that overhead and superintendence charges are generally the heaviest items on the plantations's balance sheet and naturally reduce the profits. This explains why several large estates in a group are managed more profitably than a single small estate, the planter's salary and overhead charges being spread over a greater acreage.

These calculations were made in 1922, when labour was costly and prices for cacao were lower than they had been for some years Thus in the rosy days of January, 1920, fine Trinidad cacao was fetching up to $27·50 in Trinidad and £6 10s. to £6 11s. the cwt. in London, while the average price in 1922 was $11·50 in Trinidad and £3 10s. 7d. in London. The mean price in Trinidad for the years 1918-25 was $14.

One of the most striking figures is the amount spent on pruning and trimming, which, in Mr. Stanhope Lovell's opinion, is the most important work on the plantation.

It will be at once appreciated that the cost of production for each hundredweight will vary with the yield

ESTIMATED COST OF PRODUCTION
OF EACH CWT. OF CACAO (TRINIDAD)

	£ s. d.	£ s. d.
Salaries and General Expenses—		
Overlookers	1 6	
Watchmen	1 –	
Messenger	1	
		2 7
Cultivation—		
(*a*) *Cattle Establishment :*		
Cost and keep of stock	2 4	
Upkeep of grass fields (cutting grass)	1 –	
Shoeing and harness repairs	3	
		3 7
(*b*) *Plantation :*		
Application of manure	3	
Mulching	6	
Cutlassing, weeding, and forking	2 6	
Diseases and pests (including rats, squirrels, ants, black cacao, etc.)	9	
Roads and drains	1 –	
Pruning	2 6	
Supplying cacao trees	2	
Shade trees and plants	3	
		7 11
Reaping and Preparation for the Market—		
Gathering and picking	2 7	
Heaping, cutting, extracting, and conveying to the fermentary	2 8	
Curing, sorting, and bagging	1 7	
Transport (carting)	6	
		7 4
Upkeep of Buildings, etc.—		
Repairs to buildings	7	
Miscellaneous	3	
		10
TOTAL		£1 2 3

to the acre. Professor Shephard in his economic survey concludes that in Trinidad in 1927 costs varied between $13.25 per bag (of 165 lb.) for an estate producing 5 bags per 1,000 trees, and $7.25 per bag for an estate producing 10 bags per 1,000 trees.

Cost of Production and Sale Price. To judge from the figures published in the U.S.A. Consular Report on cacao in 1912, it would appear that, in pre-war days, on the average the planter received for his beans twice

what it had cost him to produce them. Thus in San Thomé and Para the profit was 50 per cent of the value of the crop; in Ecuador it was much higher and in Grenada lower. Thus the cost of production in Grenada was 3½d. a lb. and the cacao sold for 6d. a lb.

According to Mr. Keith's figures for Ceylon in 1922, when the plantation is in full bearing each lb. costs less than 3d. to produce and sells for over 6½d. Or to express it another way, each acre brings in a profit of £9 a year.

As cacao trees are usually planted 12 ft. by 12 ft., there are 300 to the acre. A yield of 5 cwt. an acre works out at 1·87 lb. of cacao a tree, which in Ceylon, in 1922, was worth 12·5d. The cost of all work in connection with obtaining cacao from one tree in bearing, by calculation from Mr. Keith's figures, is 5·3d. a year, or on each bearing tree one makes a profit of 7·2d. (or on an acre growing 300 trees, £9).

The author promised in an earlier chapter to show how it was possible to cultivate profitably a tree which on the average gives less than 2 lb. of product a year, and trusts that the above figures have explained the mystery.

It is interesting to compare the cost of production in Nigeria where the cacao obtains a low price. In the *Bulletin of the Agricultural Department for* 1927, it records that 16 acres of experimental plots of cacao at Agege yield 3 cwt. of cacao an acre, the cacao selling for £48 12s. od. a ton. The following data are also given—

	£ s. d.
Average gross revenue for an acre	7 5 9
,, cost of labour for an acre	2 14 9
,, gross profit for an acre	£4 11 –

Labour in man days for an acre	60
Cost each man day	11d.
Return each man day	30d.

Although the return on invested capital is good, it is not advisable for one to become a planter unless one has a strong liking for the open air and agricultural pursuits. Given this, it is a very enjoyable life, and with a plodding disposition, a receptive mind, and a buoyant faith to bridge the difficult times, one's ultimate success is assured. As a writer in *The Statist* (Aug., 1919) says, " The returns on a cacao plantation, once it has attained maturity and the plants are bearing to the full extent, very soon repay the planter for his outlay, and in a few years may, if he is fortunate, place him in such a position that he is able to retire with a handsome competence on a comparatively modest outlay of capital."

Valuing an Estate. The method of valuing an estate is based either on the number of trees or on the average yield. The first is the simpler and more popular method. The actual value of the tree taken as the basis depends on the age and condition of the trees, the general character of the property, the number and state of the buildings, the productiveness of the soil, the degree of cultivation, as well as the ease of access to the plantation and its distance from the point of embarkation. In pre-war days in the West Indies it was usual to take the average value of a fully-bearing tree as one dollar. This would mean that an estate of 300 acres planted 12 ft. by 12 ft. in full bearing, would be worth £62 10s. an acre.

CHAPTER X

THE MANUFACTURE OF COCOA AND CHOCOLATE— OPERATIONS COMMON TO BOTH COCOA AND CHOCOLATE

In the chapter on the history of cocoa and chocolate, it was described how the crushed cacao bean, which contains 54 to 55 per cent of butter, gave a somewhat too fatty drink, and how the early attempts to reduce this by adding cornflour or arrowroot were followed, and largely superseded, by the method of pressing introduced by C. J. van Houten, of Weesp, the founder of the well-known firm. As the preparations containing starch or sugar cannot legally be described as pure cocoa, they will not be considered here.

When a roasted cacao bean is crushed between the thumb and forefinger, it breaks into a large number of angular fragments which are generally termed " nibs," and one can obtain a rough analysis of the cacao bean by picking out the flakes of husk or shell and the rod-like " germ " or radicle. Such an analysis would give approximately the following result—

COMPOSITION OF THE ROASTED CACAO BEAN

	Per cent
Nibs	87·3
Shell	12·0
Germ	0·7
	100·0

The shell percentage varies considerably; Ceylon and Java beans have only 8 per cent, Accra and Bahia have about 12 per cent, and Guayaquil or Grenada 13 or 14 per cent.

If one blows on to the crushed bean resting on the palm of one's hand, the shell is carried away. Turning

over the nibs one notices a characteristic fragment which looks like a very minute rusty nail. This is the germ; it will be found to be hard and flinty. While the shell and germ contain very little cacao butter, (about 3 or 4 per cent), the nib is more than half butter, and if the finger-nail is gently pressed into it, its fatty nature becomes evident. Cocoa consists simply of the finely-ground nib from which part of the butter has been pressed. Though essentially simple in outline, in factory production a dozen operations are necessary to obtain from a bag of cacao beans so many tins of cocoa. Engineers have given much attention to the various processes, and the manufacture of cocoa powder has now become one of mass production involving comparatively little manual labour.

Factory Operations. 1. *Cleaning and Sorting.* Although the cacao beans of commerce are reasonably free from foreign matter, they are liable to contain string from the bag, small twigs of dried placenta from the pod, stones, dust, etc. To remove these the beans are run over a series of rocking sieves, the separation of the lighter particles being assisted by a strong current of air. The beans, at the end of the cleaning, have lost up to 0·5 per cent by weight. The same machine also roughly sorts the beans to size, a necessary precaution if one is to obtain an even roasting. The cleaned and sorted beans are taken by a conveyor to the hoppers over the roasting machines.

2. *Roasting.* In spite of the advance of science the roasting of cacao remains a romantic occupation. For him who " rules the roast " no cut and dried rules are laid down; he is expected continuously to use his judgment, and this is necessary because cacao beans, like all natural products, show appreciable variations in size, dryness, and so forth.

The apparatus in which the roasting is generally conducted is very similar to a coffee-roaster. It consists

essentially of a heated rotating cylinder. The heat may be supplied by a coke fire, gas jets, or by superheated steam. The period of roasting and the heat supplied depend on the results desired. Some roasting amounts

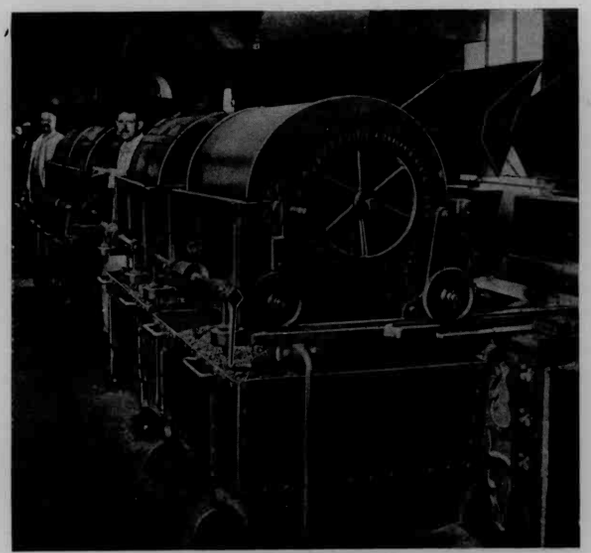

FIG. 23. DISCHARGING ROASTING CYLINDER AFTER HEATING OVER A COKE FIRE
(Messrs. J. S. Fry & Sons, Ltd., Bristol)

to little more than drying, while in other cases it is carried to within an ace of burning. The time varies from thirty minutes to two hours, and the temperature attained is comparatively low, being from 100° C. to 140° C. (212° F. to 284° F.). (It is interesting to compare coffee, the best flavour of which is obtained by roasting to 200° C. (482° F.), that is, almost to the point of burning.) The roasters are fitted with a neat sampling

INTENTIONAL SECOND EXPOSURE

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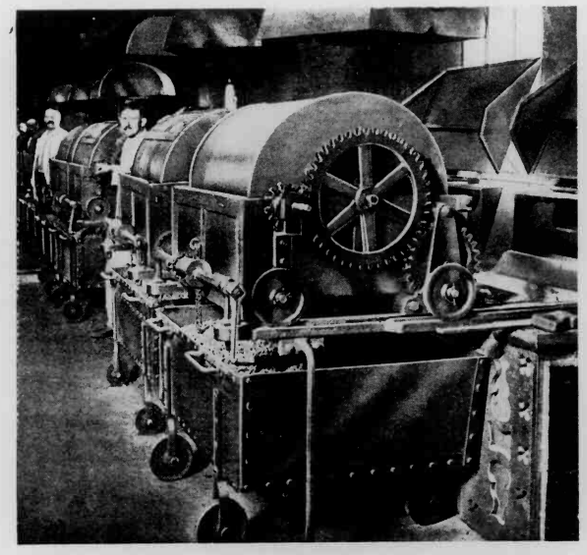

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device which enables small quantities of the beans to be removed from time to time without stopping the operation. The supervisor breaks the beans, applies his highly-trained nose to the crisp and fragrant fragments, and passes judgment. If the roast is satisfactory, the beans are immediately discharged from the roaster and rapidly cooled by a blast of cold air to stop any further changes due to heat. The roasting of cacao not only first creates, and then develops, the chocolate aroma, but also changes the colour of the kernel, even though it be violet or purple, to a chocolate brown. Further, it loosens the husk or shell, so that the removal of this in the next operation is greatly facilitated. The moisture falls from 6 or 7 per cent in the raw to 1 or 2 per cent in the roasted bean. Besides water, acetic acid and other bodies are driven off during roasting, so that the total loss averages about 7 per cent. Roasting is generally considered to reduce the astringency of the bean, to gelatinize the cacao starch, and to give a product containing more water-soluble matter. Whilst caffeine is lost in the roasting of coffee, no reduction of theobromine occurs in the normal roasting of cacao.

With regard to the chocolate aroma, Messrs. Bainbridge and Davies have made an investigation of the aroma and flavour of cocoa and chocolate. They distilled over 4,000 lb. of cacao beans and obtained less than 1 oz. of *essential oil of cocoa*. This had an intense flavour, 1 part being detectable in 50,000,000 parts of syrup. It contained a number of esters, but the chief constituent was *d*-linalool.[1]

A popular machine in U.S.A. is the Burns roaster, a revolving cylinder in which the roasting is effected by a flow of hot air through the beans, the flow being

[1] *Esters* are generally volatile liquids and occur as the odoriferous principles of fruits, etc. *Linalool*, or linalol, is an alcohol which contributes to the fragrance of bergamot and lavender.

created by a small fan in the exit draught pipe. In France spherical roasters have been used, whilst for certain Continental chocolates the beans are not roasted, but simply dried by a continuous process, a good machine for the purpose being a revolving evacuated cylinder.

3. *Obtaining Pure Nib.* All manufacturers of high-grade cocoa and chocolate do their utmost to remove the shell. The problem appears simple, one has merely to break the bean and blow away the shell. Were it possible in breaking to produce large fragments only, the separation would be easy, but the smaller the fragments, the more difficult they are to separate.

The usual method of cracking the beans is to run them through rolls. The size of aperture between the rolls is very nicely adjusted, but, as the beans vary slightly in size, while the majority are cracked into conveniently large pieces, a minority are smashed to atoms. Special machines are required to separate the germ, and usually the cracked beans pass through the germ sieve or separator *before* going into the winnowing machine which separates the shell. All methods of withdrawing germs depend upon taking advantage of their definite size and distinctive shape; as occurring in roasted beans they are 0·25 in. long and 0·08 in. wide. They are separated from the mixture either by being caught up in germ-shaped depressions, or by falling through suitable perforations, in a metal cylinder.

Practically all shell-separating machines apply the principles of grading and winnowing. Generally they consist of an inclined cylinder made up of sections of metal gauze, each with a different sized mesh. As the mixture passes down, it is sieved into the various sizes. Each of the grades meets a current of air, which carries away the shell and allows the nib to pass on. By such processes are obtained (*a*) shell almost free from nib,

(*b*) large fragments of perfectly clean glossy nib, and (*c*) a mixture of fine material which requires a further special separation. The shell is bagged up and sold, chiefly to cattle food manufacturers. The shell-free nib

FIG. 24. SHELL SEPARATING MACHINE
(Messrs. J. S. Fry & Sons, Ltd., Bristol)

is the material from which cocoa and chocolate are made.

(*a*) **Cacao Shell.** This is the principal by-product of the cocoa and chocolate industry, about 5,000 tons being produced annually in Great Britain, and 15,000 tons in U.S.A. This skin or husk is a crisp material, rich brown in colour, with a pleasant characteristic odour resembling that of chocolate. It keeps uncommonly well, and in a dry place will remain unchanged

for years, showing no signs of rancidity or mouldiness. It is bulky, the ordinary sack in which it is sold holding, according to the size of the pieces of shell, from 56 lb. to 84 lb.

A small amount of cacao shell is used in Ireland to prepare a drink called "Cocoa tea," and during the war a preparation of cacao shell for the same purpose was widely advertised in England under the name of "Celesco." A more important use of cacao shell, however, is in the manufacture of compound cattle cakes. In the standard exposition of "The Valuation of Feeding Stuffs," by Mr. A. Smetham (*Royal Lancashire Agricultural Society's Journal*, 1921), two analyses of cacao shell are recorded.

CACAO SHELL
ANALYSIS AND FOOD UNITS

Water	Oil	Albuminoids	Digestible carbohydrates	Woody fibre	Mineral matters	Sand and silica	Food Units
9·30	3·83	18·81	46·01	13·85	8·20	0·85	102
9·50	8·97	17·13	39·35	16·60	8·45	1·00	104

The analytical figures for pure Accra shell will be found in the chapter on "Composition and Food Value," its energy-giving power in calories per lb. being 1,354.

In the Sale of Fertilizers and Feeding Stuffs Act (1927) cacao shell is not specifically mentioned, but apparently comes under the Third Schedule of Ingredients, which includes husks, chaff. shudes, skins, etc., although it is superior to most of the materials under this heading. The presence of these ingredients in a compound feeding stuff must be declared.

Considering its food value, the cost of cacao shell is low. The average price is about £5 a ton, or roughly about 1s. the food unit. Cacao shell is distinguished from all other feeding stuffs by the presence of 0·2 to 3·0 per cent of theobromine. The theobromine is a

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valuable stimulant, but its presence makes it advisable to avoid an excessive proportion of cacao shell in a diet. Cacao shell should therefore be used chiefly as an appetizer, and the best results will be obtained if the daily quantity fed is small; thus for a cow it should not exceed 3 lb. It is not a suitable feed for horses,

FIG. 25. GRINDING CACAO NIB BETWEEN STONES
(Messrs. J. S. Fry & Sons, Ltd., Bristol)

but it has been advantageously used by Vezzani and others to improve the flavour of pig-food in amounts not exceeding 5 per cent.

Cacao shell has been looked at from time to time as a cheap by-product of which more effective use might be made. It is used as a cocoa substitute in cheap chocolate confectionery. It is one of the sources of theobromine, from which is prepared a number of valuable medicinal preparations. The extraction of the

theobromine is generally preceded by the extraction of the shell butter, which is sold as a cacao butter substitute. Its possible use has been explored in a number of curiously diverse directions— a coffee substitute has been prepared from it, it has been tried out as a packing material, as a manure, and, somewhat unsuccessfully, as a source of power alcohol.

(*b*) **Cacao Nibs.** While the complete removal of the shell is well-nigh impossible, in good factory practice not more than 1 per cent is left in the nib.

The nibs were once an important article of commerce, and to this day doctors sometimes recommend their patients to prepare a drink by making a water infusion of the nibs, a costly and wasteful method of preparing a thin beverage.

The losses on cleaning (0·5 per cent) and roasting (7 per cent) have already been noted. In obtaining the nib a further loss occurs due to the removal of the shell, about 10·5 per cent of which is readily separated as coarse shell. When all the fractions have been sorted, about 80 parts of usable nib are obtained from every 100 parts of raw beans. It will be appreciated that the value of the roasted cacao nibs is much higher than the price of the raw cacao. The manufacturer has to pay duty and freight and other charges before he gets the beans into the factory. Then he has the expense of the labour, power, and heating in the cleaning, roasting, and winnowing operations. The 20 per cent loss on the beans is equal to an increase in the cost of 25 per cent on the nib, and the value of the shell, etc., separated is comparatively small.

4. *Grinding the Nib.* This is accomplished by means of a grinding mill consisting of several pairs of French burr stones. One stone is revolved on the top of another which is stationary, the nib being automatically fed into the plane of contact down a central hole in the upper stone. The nib contains over half its

INTENTIONAL SECOND EXPOSURE

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weight of fat, and as the nib is crushed, the cells are broken and the fat liberated. The grinding process generates heat, and at 90° F. the fat melts to an oil. This explains why the crisp, nutty cacao nib, after passing between the stones, emerges as a thick brown

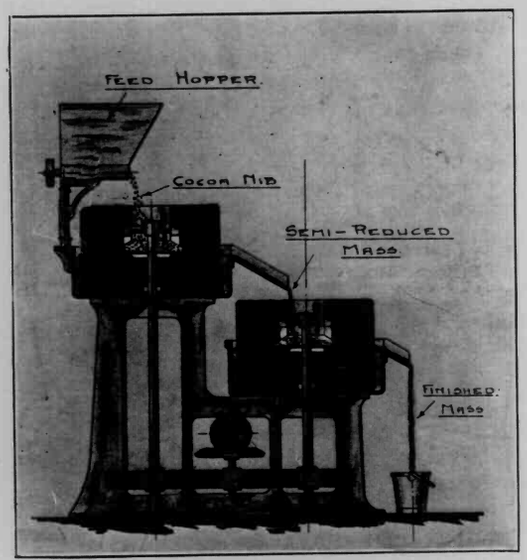

FIG. 26. SECTION THROUGH GRINDING STONES
The surfaces of the stones are grooved so as to give a slicing or shearing action

liquid. According to the fineness of particles required, the nib is passed through one, two, or three pairs of stones. The material obtained is liquid cacao nib, which on cooling sets to a hard brown block. This is known as cacao mass or unsweetened chocolate, and can be used to prepare either cocoa or chocolate. The illustration (page 120) of grinding as it used to be done at Messrs. Fry's is historically interesting as it shows a

circle of grinding stones driven in an unusual manner by a huge spur-wheel, which is 18 ft. in diameter and weighs $3\frac{3}{4}$ tons. The diagram shows two grinding sets one above the other, and triple mills are now frequently used. A number of attempts have been made to replace the mill stone, which has been used to grind cacao nib from the earliest days of factory production. In some factories the nib is ground on steel roll refiners, resembling those used for chocolate. Special machines have been devised for the purpose by Messrs. Buhler Bros., and by Messrs. Lehmann. A method which is popular in America is the use of the Bausman disc machine, in which the grinding is accomplished by running the nib between a revolving and a stationary vertical steel disc, both suitably grooved and set very close together.

So far cocoa and chocolate have been considered together, but from this point their methods of manufacture are totally different.

CHAPTER XI

MANUFACTURE OF COCOA AND CHOCOLATE (CONTD.)

OPERATIONS PECULIAR TO COCOA AND CACAO BUTTER PRODUCTION

1. *Pressing out the Cacao Butter.* In the preceding chapter, the processes for the production of ground cacao nib or unsweetened chocolate were briefly described. The next process in the production of cocoa is the removal of part of the cacao butter. The machines used are similar in principle to those generally used for pressing the oil out of seeds and nuts, but, whereas most of these are pressed in a whole or mealy condition, in this instance the material to be pressed is a liquid, carrying only very fine particles in suspension.

The modern cacao press consists of a number of circular pots arranged vertically one above the other. A filter cloth having been placed on the perforated plate which forms the bottom of the pot, about 20 lb. of hot liquefied cacao bean is run into the pot and the top covered with a filter cloth and perforated plate. Hydraulic pressure up to 6,000 lb. to the square inch is applied to the pile of full pots. The butter which escapes through the perforations is carefully collected. It is coloured brown by a trace of ground cacao bean. After pressing, the material left in the pot is no longer a liquid but a hard brown disc, weighing about 12 lb., and looking for all the world like a gigantic pine lozenge. The cake may contain anything between 20 and 30 per cent of cacao butter, and has only to be ground up and sieved to become cocoa.

2. *Obtaining the Powder.* The press-cakes are crushed between toothed rollers, and passed through other grinding or disintegrating machines which reduce them to a fine powder. As it is important that the cocoa

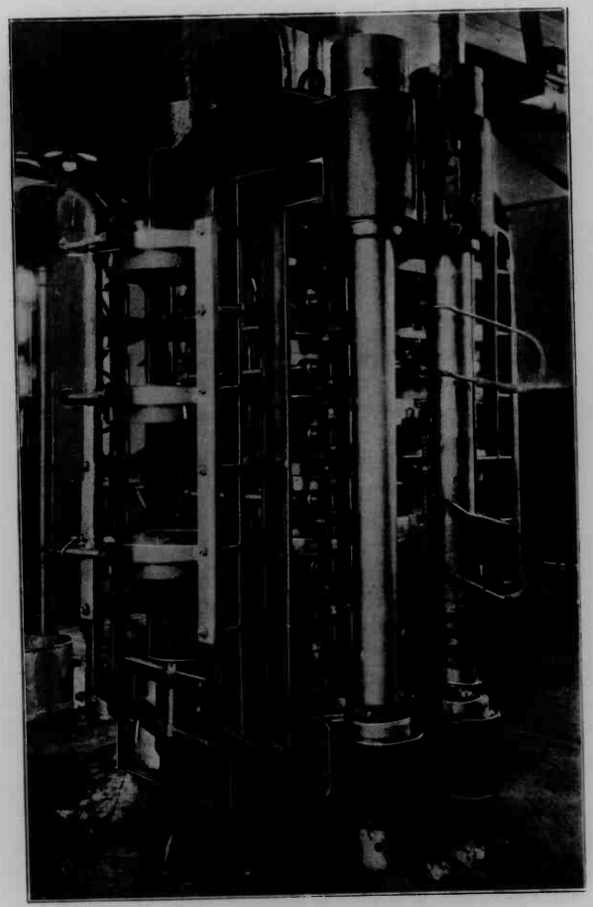

FIG. 27. COCOA HYDRAULIC PRESS
(Messrs. Rowntree & Co., Ltd., York)

INTENTIONAL SECOND EXPOSURE

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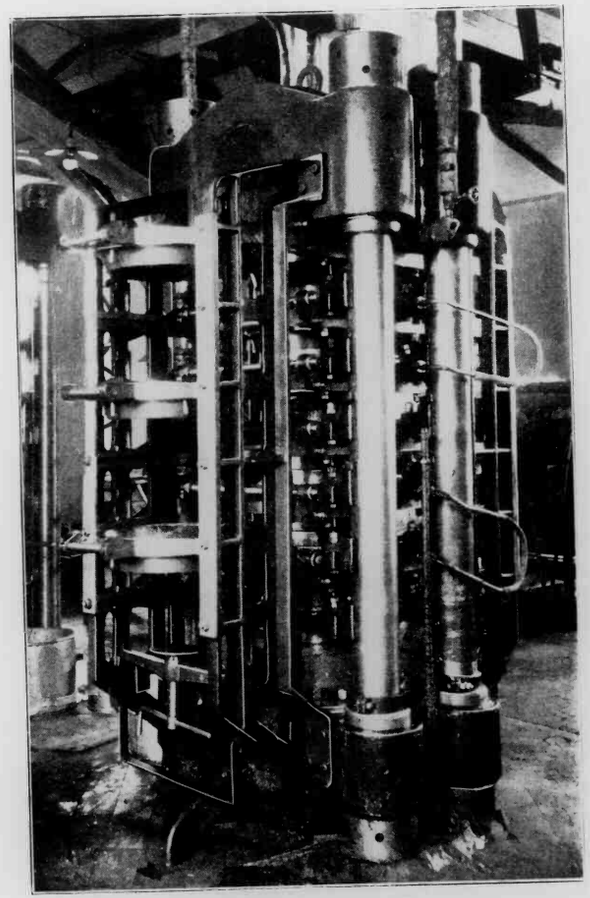

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should be a very fine and even powder, great care is taken in sieving it. In some factories a vast space is devoted to an elaborate system of sifting by means of wind, only those cocoa particles which settle in almost still air being used. The more usual process is to sieve the powder in a revolving, inclined hexagonal drum, the sides of which are made of fine silk gauze.

3. *Packing.* The modern automatic weighing, packing, and labelling machines are marvels of ingenuity. The tins follow one another in single file. The machine turns the band of paper into bags and inserts one in each tin. The empty, open tins or packets stand like a waiting procession, and one by one are brought under a stream of cocoa which is cut off automatically when the correct weight has been supplied. The machine gently bumps the packet to shake down the powder, inserts a check coupon, puts a dab of gum on the paper, and closes the packet. Later, one sees the filled circular tins rolling merrily along, one after the other, over a pile of gummed labels. A label adheres to each tin, and they roll out of the machine in a condition suitable for dispatch to the grocer's shop.

4. *"Soluble" Cocoa.* Besides the cocoas prepared in the simple manner described above, there is an important class which is called "Soluble" cocoa. These cocoas are obtained by treating the cacao with an alkali or salt of the alkalis. The originator of this process was C. J. van Houten, and it is generally known as the "Dutch method." Similar methods are now followed very widely, and, with notable exceptions, the majority of the cocoa powders on the market are prepared in this way. Both the alkaline substance and the method of application vary. Potassium, sodium, ammonium or magnesium carbonates or bicarbonates are used in quantities of 2 to 3 per cent. Either the roasted nib, or the ground paste, or the cocoa powder itself is treated, usually in a steam-jacketted kneading

FIG. 28. MODERN BAG MAKING AND WEIGHING MACHINES
(Messrs. Cadbury Bros., Ltd., Bournville)

INTENTIONAL SECOND EXPOSURE

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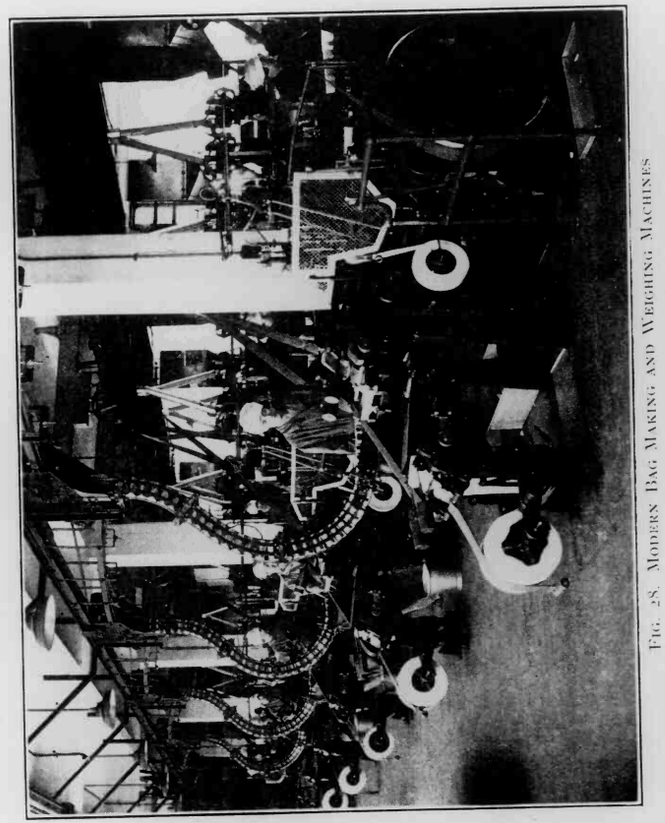

FIG. 28. MODERN BAG MAKING AND WEIGHING MACHINES
(Messrs. Cadbury Bros., Ltd., Bournville)

or mixing machine. Every one is familiar with the use of a bicarbonate in baking. In ordinary baking powder the sodium bicarbonate is neutralized by tartaric acid. In the process under consideration, the alkali neutralizes, and is neutralized by, the natural acidity of the cacao bean. The effects are to destroy partially the characteristic bouquet of cacao, to give a darker colour, and, in the opinion of many, to improve the flavour. One of the objects of using alkalis is to increase the buoyancy of the particles, and hence to produce a cup of cocoa which is homogeneous and which takes a long time to settle out. Strictly speaking, the product cannot be described as " soluble." The effect of the treatment is not to make the cocoa soluble, but more suspendable; certain changes, such as the loosening of the component parts and the effect of a neutral solution on the colloids, tending to this end.

The word " alkali " has an objectionable " chemical " sound. The writer, however, does not propose to thrust up this discarded bogy before an astonished public. It may be well to state that the use of this word in connection with the finished cocoa powder, as made by reputable makers, is incorrect. After treatment the cocoa contains no alkali in the free state or as carbonate; it apparently becomes converted into salts similar to those found in foods of purely animal and vegetable origin. Where alkaline salts are used with understanding and discretion, their employment becomes entirely a question of taste.

Judging Cocoa. Cocoa should be absolutely pure and possess a fine flavour. Apart from the question of adulteration, which is dealt with in a separate chapter, the value of a cocoa is related to its composition, in particular to the amount of cacao butter present and the care with which the cacao beans have been selected.

In the choice of bean and care in preparation, the proprietary brands are generally superior to the cocoa sold

FIG. 29. AUTOMATIC WEIGHING MACHINE FOR COCOA POWDER
(Messrs. Cadbury Bros., Ltd., Bournville)

INTENTIONAL SECOND EXPOSURE

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loose. The professional cocoa-taster is influenced by the colour and aroma of the powder, but the determining factor naturally is how it makes up with water. He notes the flavour, aroma, body, and strength. In judging the flavour of the liquor, he usually tastes it without sugar or milk. He also carefully observes the amount of sediment left in the cup.

It may be well to describe how cocoa should be prepared in the household to obtain the beverage at its best. The operation which is most neglected is the use of the whisk. For each cup of cocoa required put one piled teaspoonful of cocoa into a jug, add an equal number of teaspoonsful of sugar, and mix dry. Bring a mixture of equal parts of water and milk to the boil in an aluminium or enamelled saucepan, pour the boiling milk over the cocoa and stir briskly. Put the whole back into the saucepan and boil for one minute. Transfer back to the jug, whisk vigorously, and serve whilst steaming hot.

Cacao Butter (Oleum Theobromatis). French—*Beurre de cacao*, German—*Kakaobutter*, Spanish—*Manteca de coco*, Italian—*Burro di cacao*.

Cacao butter as it flows from the press is brown. When it has been passed through cloth in a filter press, it becomes a crystal-clear, amber-coloured oil, which sets to a brittle, pale yellow solid with a characteristic fragrance. Though brittle at ordinary temperatures it melts readily in the mouth (at 90° F.). It has a pleasant taste, suggestive of cocoa, and is noted amongst butters for its good keeping properties. Its colour, however, fades on exposure to light.

As far as elementary composition is concerned, cocoa is the ground cacao bean from which some of the cacao butter has been pressed, and chocolate is ground cacao bean and sugar with or without the addition of cacao butter. Owing to the growing demand for chocolates rich in cacao butter, and also for milk chocolate, cacao butter, the by-product of the cocoa industry,

has become the life fluid of the chocolate industry. The surplus of the one is a necessity of the other, so that while the manufacturer sets out to make cocoa, the demand for cacao butter is such that the accessory product may obtain the higher price. In the early days the cacao butter was a by-product of no great value.

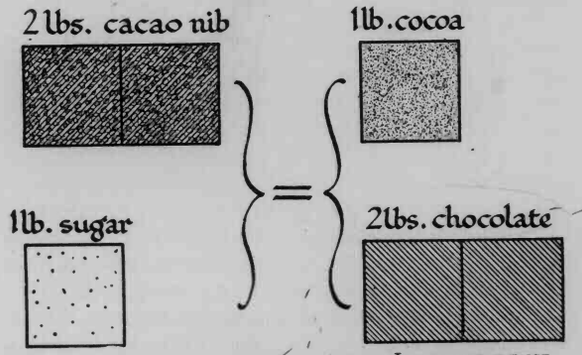

FIG. 30. DIAGRAM ILLUSTRATING ROUGHLY INTERDEPENDENCE OF COCOA AND CHOCOLATE

With the increase in the consumption of chocolate the value of cacao butter improved. Before the war there was a period when the amount of cacao butter pressed in the production of cocoa was just about sufficient to meet the requirements for chocolate. Since then the consumption of chocolate has gone up by leaps and bounds. This is due to a general increase in consumption and also to the men joining the women and children as consumers and taking their share of chocolate. The enormous popularity of milk chocolate, which is a great cacao butter consumer, has made the position even more acute, and to-day we find many tons of cacao beans used mainly for the butter they contain. Cacao butter for some years has been the most expensive of the vegetable fats that are of commercial

importance; in 1919 it rose to 2s. 11d. a lb., the highest wholesale price on record.

Below will be found the wholesale prices for the last six years, together with the quantities imported into England—

CACAO BUTTER

Year	Imported into United Kingdom	Wholesale price per lb. Prime English. Duty paid. Delivered
	Tons	*s. d.*
1923	1,605	1 $3\frac{1}{2}$
1924	1,742	1 $2\frac{1}{16}$
1925	1,400	1 $3\frac{3}{4}$
1926	1,328	1 $3\frac{5}{8}$
1927	2,311	1 9
1928	3,024	1 $8\frac{1}{16}$

Holland, with its large cocoa factories, is the principal exporting country, and an important butter auction is held in Amsterdam. The following table shows the amount exported and the average wholesale prices from 1923 to 1928. Duty would have to be paid on the butter coming into England—

AVERAGE PRICE OF DUTCH CACAO BUTTER
Net f.o.b. Amsterdam

Year	Exported from Holland	Van Houten "AA" (formerly "A")	Van Houten "A" (formerly "B")
	Tons of 1,000 kilos	Per lb. *s. d.*	Per lb. *s. d.*
1923	9,049	1 $2\frac{1}{4}$	1 $0\frac{3}{4}$
1924	11,887	1 $0\frac{14}{16}$	11 $\frac{7}{16}$
1925	12,467	1 $2\frac{9}{16}$	1 $1\frac{5}{8}$
1926	13,676	1 $2\frac{9}{16}$	1 $1\frac{3}{8}$
1927	12,623	1 $9\frac{1}{16}$	1 $6\frac{1}{2}$
1928	13,720	1 $7\frac{1}{8}$	1 $4\frac{13}{16}$

A little cacao butter is used in pharmaceutical preparations, for lip-stick and as a grease-paint remover, but its main use is in the manufacture of chocolate. No other fat is quite as good for this purpose, although a fair substitute, illipé butter, and a clever imitation,

a hardened oil, are now on the market. Cacao butter is an example of an important article of commerce, like agar-agar, ambergris, copra, and cacao beans, which the public, under normal conditions, never sees. When in 1918 the world was pining for cooking fats, and beautiful blocks of cacao butter, weighing a quarter of a hundredweight, were exhibited in grocers' windows, the general public had not the faintest idea what it was or where it came from. The housewife found it so hard that it had to be grated to use in cakes, and the flavour which makes it so delightful in chocolate, did not by any means improve fried fish or chip potatoes. The newspapers, ever anxious to help, explained that the flavour could be driven off by heating the cacao butter to 320° F. In spite of the interest shown, as soon as the price of butter, lard, and margarine dropped to more reasonable figures, the public demand for cacao butter ceased and it returned to its normal use.

Chemists, and others, will be interested in the following list of analytical figures. All these figures, save the last three, have been compiled from the examination of many cacao butters produced in a cocoa factory—

ANALYTICAL FIGURES FOR CACAO BUTTER

Specific gravity (at 99° C. to water at 15·5° C.)	·858 to ·865
Melting point	32° C. to 34° C.
Titer (fatty acids)	49° C. to 50° C.
Iodine absorbed	34% to 38%
Refraction (Butyro-refractometer) at 40° C.	45·6 to 47° (Dispersion 0·00827)
Saponification value	192 to 198
Valenta	94° C. to 96° C.
Reichert Meissel value	0·2 to 0·5
Polenske value	0·3
Kirschner value	0·5
Shrewsbury and Knapp value	14 to 15
Unsaponifiable matter	0·3% to 0·8%
Mineral matter	0·02% to 0·05%
Acidity (as oleic acid)	0·6% to 2·0%
Baryta values—Total	265
Insoluble	258
Soluble	7
Avé-Lallement	51 to 53
Coefficient of expansion 1° C.	0·000772

CHAPTER XII

THE MANUFACTURE OF COCOA AND CHOCOLATE (CONCLUDED)

OPERATIONS PECULIAR TO CHOCOLATE

CHOCOLATE is made for eating and drinking. It will be remembered that the author uses the word cocoa solely for cocoa powder (*Cacao en poudre*, French; *Kakaopulver*, German; *Cacao en polvo*, Sp.; *Cacau em po*, Port.; *Cacaopoeder*, Dutch). As there is in Britain no legal standard for, or definition of, chocolate, it may be well to explain how the word is used here. Chocolate is any preparation of roasted cacao beans, generally without the abstraction of butter. High class chocolate contains no other ingredients than cacao nibs, sugar, and cacao butter, save the small quantity of substances added as flavouring. Whereas chocolate for eating generally contains 50 to 55 per cent of sugar, chocolate powders for preparing the beverage may contain up to 75 per cent. Since the introduction of cocoa, drinking-chocolate has declined, and eating-chocolate has risen, in importance. The latter will be mainly considered here.

Since "nature's confectioner, the bee," set the pace by making honey, human creatures have striven to produce things both sweet and delectable, and chocolate is one of man's masterpieces. The manufacturer in seeking to establish a brand aims at producing an unchanging product of marked individuality. To do this he uses a particular blend of beans, and prepares them in a definite way to develop a characteristic flavour. He may intensify the individuality of the flavour by adding a small quantity of coffee or roasted almonds. And as aroma is a part of flavour he will probably add a minute quantity of vanilla or vanillin,

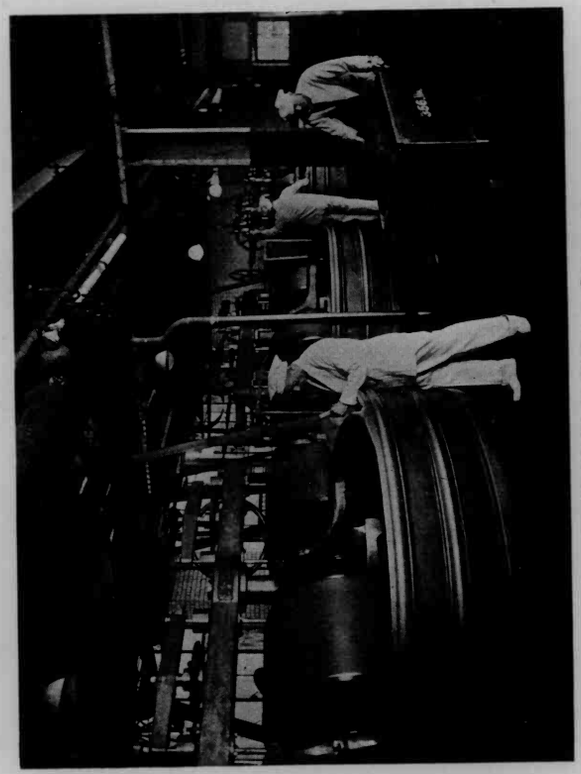

FIG. 31. MELANGEURS REFINING CHOCOLATE
(By courtesy of Messrs. J. S. Fry & Sons, Ltd., Bristol and Somerdale)

INTENTIONAL SECOND EXPOSURE

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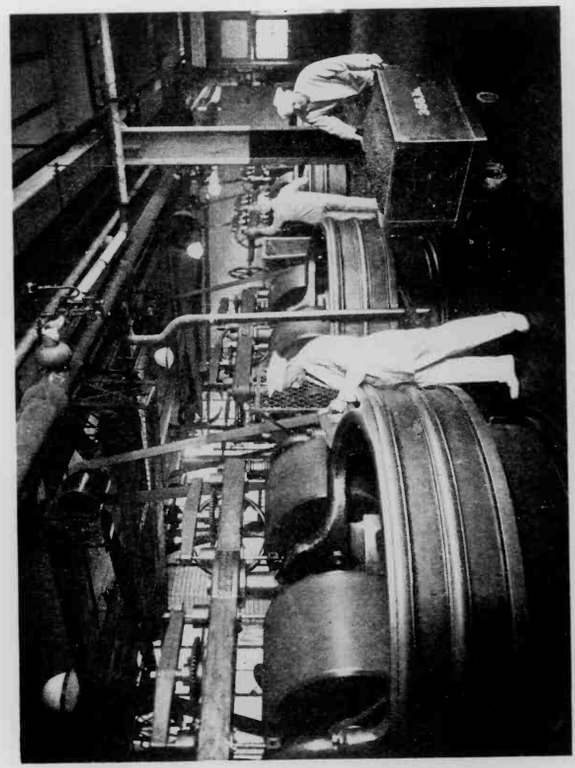


FIG. 31. MELANGEURS REFINING CHOCOLATE
(By courtesy of Messrs. J. S. Fry & Sons, Ltd., Bristol and Somerdale)

coumarin, or heliotropin; or odoriferous spices like aniseed, cinnamon, or nutmeg; or aromatic bodies like balsam of Peru, gum benzoin, or attar of roses.

The variations on the fundamental processes are too many to be described here, and only the essentials will be briefly mentioned. The original method of making chocolate with a mortar and pestle has been expanded in the factory into a number of operations known as grinding, melangeuring, refining, and conching. The roasted or dried nib is finely ground either by mill-stones, or steel rolls, or between revolving steel discs. In some factories the nib and sugar are ground together. More generally the sugar is ground separately to an almost impalpable snow-white powder either in a mill resembling a mortar mill or else in a modern type of disintegrator, such as the Woodburn. In some cases the sugar is further separated into degrees of fineness by wind sifting. An interesting method of producing fine sugar is the so-called " amorphous " sugar process in which a concentrated sugar syrup is crystallized by passing through a transformer (Patent 132,200, 1919). The ground nib and sugar are then mixed in suitable proportions. Whymper cites the following recipe as giving an eating chocolate possessing a very good flavour—

RECIPE FOR PLAIN EATING CHOCOLATE

	lb.
Caracas nib	16½
Para nib	9¼
Trinidad nib	18½
Sugar	55¾
Vanilla	¼
	100

The mixing is done in a machine called a *melangeur*, a refined kind of edge-runner, which consists of two heavy granite rollers resting on, and revolved by, a rotating granite bed. The melangeur is kept warm and

the mixture now attains a soft and plastic condition. This is chocolate in the rough, and, though gritty to the teeth, would have satisfied consumers fifty years ago. It is discharged as a dough from the melangeur by lowering a directing blade into the revolving paste. This chocolate dough is now put through a refiner, a kind of " mangle *de luxe*," that is to say, it is given a

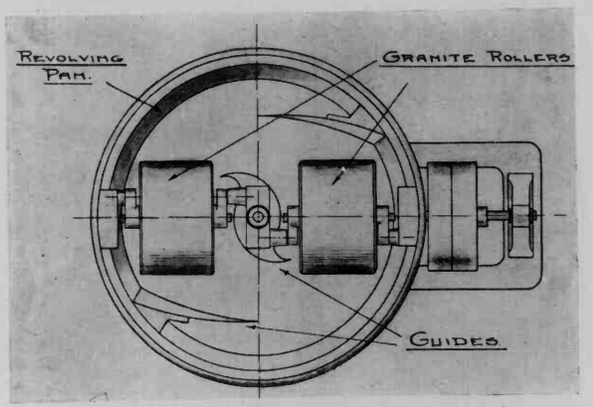


Fig. 32. Plan of Chocolate Melangeur

number of grinds between granite, porcelain, or steel rolls. The chocolate goes into the nip of two rolls revolving at different speeds, so that the particles are torn apart as well as crushed. As overheating would be detrimental to the chocolate, the steel rolls are water-cooled. As the cooling at the ends is less effective than at the centre, the ends tend to get hot and expand. This expansion is allowed for by making the rolls slightly tapered.

One effect of the refining is to make the dough stiffer or to convert it into dry flakes. It is now put into a hot cupboard to recover its plasticity, or, to

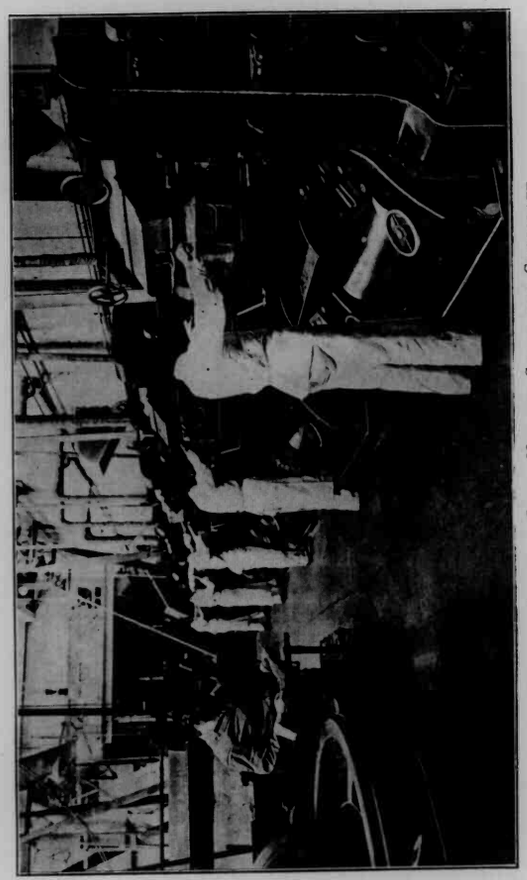


FIG. 33. GRINDING CACAO NIB AND SUGAR FOR CHOCOLATE
(Messrs. Cadbury Bros., Ltd., Bournville)

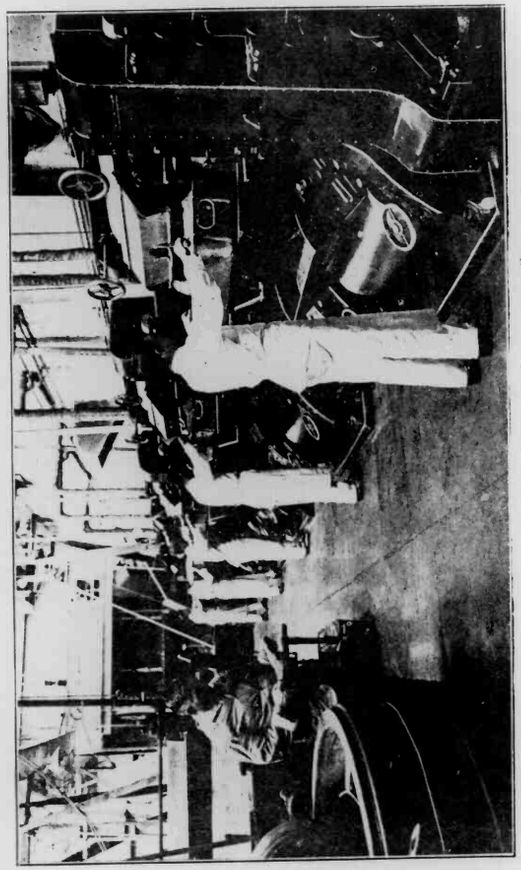
obtain the same effect, mixed in a melangeur with a little cacao butter. It is generally believed that the stoving, melangeuring and exposure to air help the development of the full chocolate aroma. Grinding and melangeuring are repeated three, four, or five times, until the chocolate is fine enough to satisfy the public taste.

The crunchy chocolates which sold in quantity only ten years ago have gone, the public now demanding a chocolate with a smooth velvety feel. This is most effectively obtained by means of a machine peculiar to chocolate, called a *conche*, in which the chocolate is worked continuously for three or four days. Along the concave bottom of the conche a heavy roller is thrust backwards and forwards under the chocolate. This drives the chocolate forcibly against the arched ends, alternately compressing and stretching it. Many clever attempts have been made to supersede this tedious and costly process, but, in spite of local secessions, it still holds the field.

If the conching effect is obtained by slapping the chocolate about in the presence of air, some of the various machines recently introduced may prove more economical than the conche. They consist mainly of drums with revolving arms, in some cases connected with pumps to give either a partial vacuum or to suck air through the rotating mass.

Two quite different developments are worth mentioning—one in which the ordinary longitudinal conche rollers are fitted into a circular pan, and the other the rotating conche made by J. S. Petzholdt. This machine has an intense turbine action, which, according to the inventor, " completes the final development of the cocoa aroma and results in a very intimate association of cacao, cacao butter, and sugar." Several theories have been put forward to explain what happens in the conche, and the following is quoted from Petzholdt's

INTENTIONAL SECOND EXPOSURE



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contribution to the question: " It has quite recently been ascertained, by scientific analyses, that the so-called conching effect is a most considerable trituration or grinding. The following results have been found with the aid of the ultra-microscope: the most modern (steel roll) refiner grinds the particles down to an average fineness of the granules of about 2·5 microns[1] (1 micron = one-thousandth of a millimeter). A greater fineness of the granules cannot be obtained by refining, not even by passing through the refiner three or four times more than usual. . . . A chocolate, however, the particles of which have an average size of 2·5 microns, still has a gritty taste to the palate. Smooth chocolate therefore requires a considerably finer trituration. Experience has proved that this further reduction cannot be obtained but by conching. With the aid of the ultra-microscope it has been verified that longitudinal working of the mass for 72 hours brings down the size of the granules to an average of 0·8 microns.

" Now the form of the smallest particles, as it is produced by the trituration, is important, because the taste depends upon this shape.

" The trituration between the rollers (of the ordinary grinding machines) is effected by two cylinders moving with different speeds, rending the particles. The grain afforded by the rollers therefore proves, when examined under the ultra-microscope, to be flat and sharp-edged.

" The trituration process of the conches is mainly a pressing and rubbing of the smallest particles against one another. Thereby their edges and points are ground off, and a spherical grain is produced. These rounded and much smaller particles, as they come out of the conche, give, of course, an exceedingly more agreeable and smooth taste to the palate than the larger and sharp-edged grains obtained by refining." Petzholdt also claims that conching removes moisture and certain

[1] 2·5 microns is about ·0001 in.

of the substances produced during the fermentation of the bean.

The remaining processes are concerned with making the chocolate look pleasing to the eye. The chocolate dough is moulded into bars, cakes, discs (croquettes),

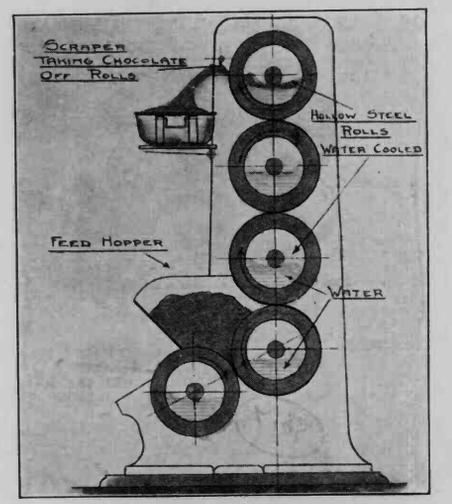

Fig. 34. Section through Chocolate Grinding Rolls

or small rectangular tablets (Neapolitans). There are a number of processes concerned in the production of the moulded form—

1. The melted chocolate must be maintained in exactly the correct condition. This is done in some form of tempering machine, a common type of which consists of a circular water-jacketed container with revolving stirrers. According to Zipperer, the temperature of the chocolate should be 28° C. (82° F.) on a hot summer day, and 32° C. (90° F.) in the winter.

2. The melted chocolate has to be divided into portions of the desired weight, and the weighed portions of chocolate dough deposited into brightly-polished metal moulds. The modern mould-filling machines will deposit 50,000 bars or 200,000 Neapolitans a day.

3. The chocolate dough must be persuaded to lie down evenly in the mould. This is accomplished by giving the track on which the moulds rest a series of violent blows, which cause the chocolate to spread down into every crevice of the mould. The blows follow one another rapidly, and are delivered at such an angle that the mould does a series of kangaroo leaps along the track and lands neatly on a belt which takes it through a cooling chamber. If the cooling and other processes have been carried through correctly, it is merely necessary to turn over the mould and give it a gentle tap when out will fall the bar, or cake, which will have the glossy appearance, the rich brown colour, and the crisp snap of good chocolate.

The wrapping in tin or aluminium foil and coloured paper is done by machinery, and much attention is given to the appearance of the package. Old Gorgon Graham says, "The package doesn't count after the eye has been attracted to it, and in the end it finds its way to the scrap heap. It's the quality of the goods inside which tells." This is no doubt true in the long run, but to please the eye is the first step towards pleasing the palate.

Covering Confectionery with Chocolate. While plain chocolate deserves its popularity not only on account of its flavour, but also because it is a convenient and compact form of nourishment, the property that chocolate has of blending with most flavours and, in the form of an "overcoat," of protecting and preserving the confection inside, has led to a huge development of the industry. Crêmes, soft caramels, and liqueurs

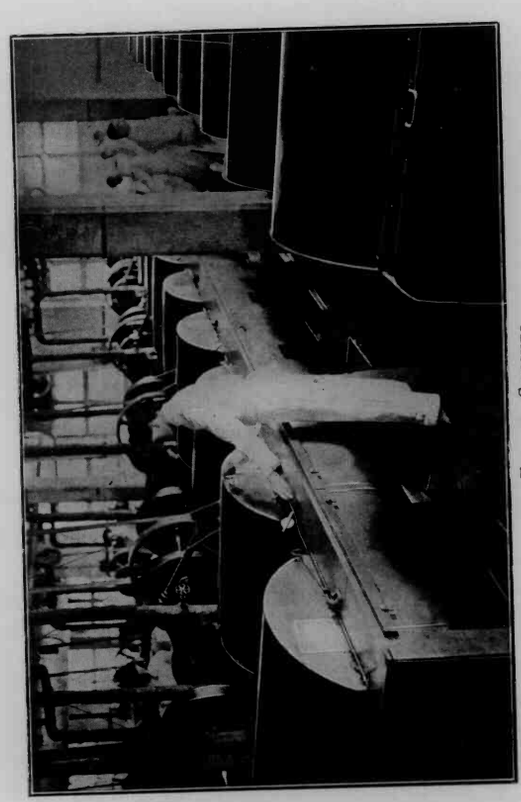

FIG. 35. CONCHES
(Messrs. Cadbury Bros., Ltd., Bournville

INTENTIONAL SECOND EXPOSURE

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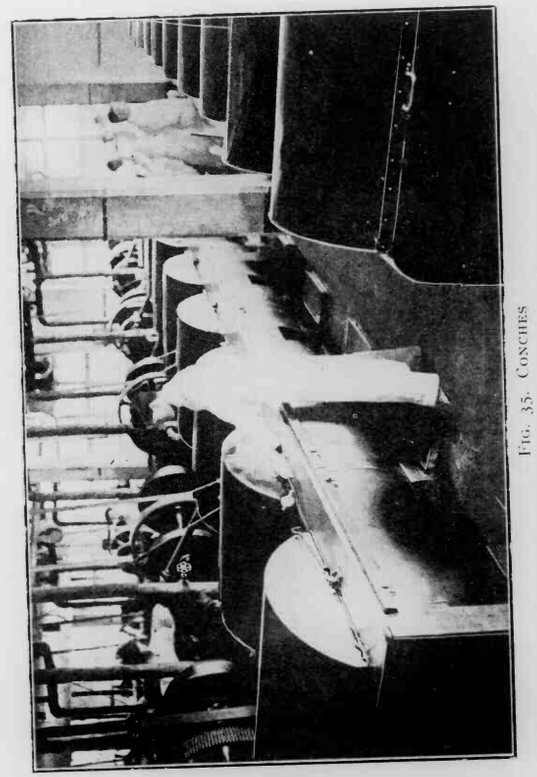

FIG. 35. CONCHES
(Messrs Cadbury Bros., Ltd., Bournville

are covered in this way, as well as roasted nuts, ginger croquant, nougat, and indeed almost everything that contains or harmonizes with sugar. In 1922 some ingenious American created a boom in chocolate-covered ices, which were sold under the quaint name of "Eskimo pie."

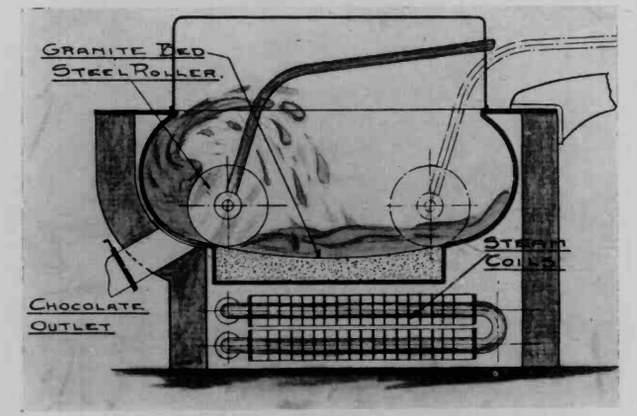

FIG. 36. SECTION THROUGH LONGITUDINAL CONCHE

Every year sees chocolate or chocolate flavouring growing in popularity. For example, to-day, no tea-table is complete without chocolate-covered biscuits.

The centres of chocolate crêmes or fondants consist simply of sugars (cane sugar, dextrose, levulose, etc.) crystallized from a hot super-saturated syrup by cooling and agitating. The crystals are so minute that the mass feels perfectly smooth and creamy on the tongue. The individual crêmes are obtained in a very ingenious machine. The liquid crême is deposited automatically from a row of small outlets into some hundreds of rows of moulded impressions in trays of cornflour. When they are set they are easily separated mechanically

from the flour. Other confections, like marshmallow and Turkish delight, are given form and shape in the same manner.

Covering chocolate may be prepared in the same way as plain chocolate, save that more cacao butter must be added to give the necessary fluidity. The best covering is done by hand. The following directions may prove of use to confectioners and others who purchase covering chocolate and cover their own confectionery. In order to get a fine colour and gloss it is necessary to have the chocolate in the right condition. Two or three pounds of a slab of covering chocolate (or *couverture*) are broken up and dropped into a suitable vessel, preferably of metal. The vessel is placed in a warm spot or in warm water, which should not be hotter than one can comfortably bear with the hand, until the whole of the chocolate is melted. It should now be well mixed and cooled by dipping the vessel in cold water, taking care that no water gets into the chocolate. The chocolate will begin to thicken. Let it cool until it is too thick to use, then warm it a little, mixing or spattling vigorously with a spoon or spatula until it is just thin enough for covering purposes. Those who use thermometers will find that the correct temperature for the chocolate is about 88° F. or 31° C. In the actual process of dipping, what is to be the top of, say, a caramel, is rested on a light two-pronged fork and dipped underneath the chocolate, and moved to and fro. When it is removed, completely covered, it is given a slight shake or tap to remove the surplus chocolate and turned over on to a piece of smooth paper, and as the prong is removed it is drawn across and lifted from the surface so that the chocolate following the prong gives a characteristic mark. When a paper has been filled with chocolates it is put aside to cool and set, or dry, as it is called.

A number of machines are now used for the covering

of confectionery with chocolate, the first of its kind being the Enrober made by Savy Jeanjean in 1903. The crêmes or other " centres " which are to be coated or enrobed with chocolate are arranged in rows on a moving canvas belt which passes them on to a woven wire conveyor. The army of centres are marched straight through a miniature cascade of chocolate, the surplus of which is shaken off and passes through the wire belt. The coated crêmes now pass on to a canvas belt which conveys them through a cooling tunnel to the girls who pack them into boxes.

The production and boxing of chocolate-covered goods in all their variety of substance, form and decoration entail much hand work, and are the greatest labour-absorbing items in the cocoa and chocolate industry. They explain also the high percentage of feminine labour employed therein.

Milk Chocolate. The incentive of competition is a poor thing beside the stimulus of creation. Few things have resulted in more solid delight for children than the invention of milk chocolate. It is one of those little inventions which matter to a million people. Some of these pass unnoticed—no song was ever made about the man who put the hump on the hairpin—but the names of Sir Hans Sloane, the original inventor, and Daniel Peter, re-inventor and large-scale manufacturer, should not be forgotten. It is now manufactured in a variety of ways direct from fresh milk, from condensed milk and from milk powder. According to Dr. Bywaters, " In spite of the modern methods of preparation of dried milk powder, it seems as if the milk chocolate obtained by its use is lacking in the velvety smoothness which characterizes the milk chocolate obtained from liquid milk." [1] This probably explains why Cailler's and Cadbury's have factories right in the heart of the milk-producing areas. Save for

[1] Page 227, *Modern Methods of Cocoa and Chocolate Manufacture.*

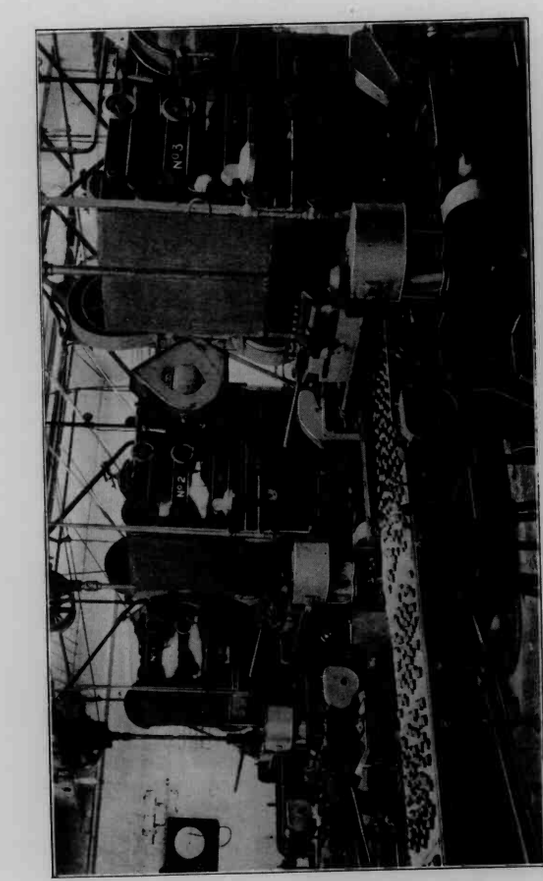

FIG. 37. ENROBER MACHINES
(Messrs. Rowntree & Co., Ltd., York)

INTENTIONAL SECOND EXPOSURE

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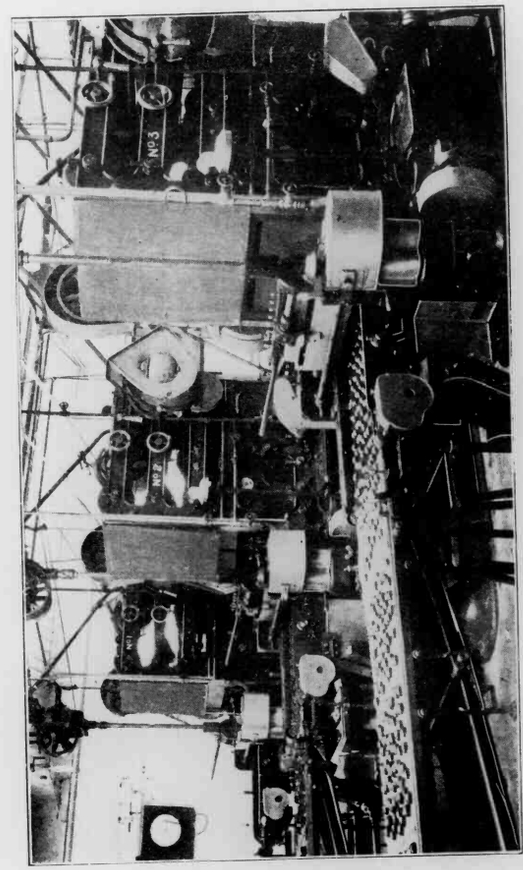

FIG. 37. ENROBER MACHINES
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the method of incorporating the milk, the mixing, grinding, conching, and moulding are similar to the processes used for plain chocolate. Those who wish to

FIG. 38. COVERING CRÊMES, ETC., WITH CHOCOLATE
(Messrs. Cadbury Bros., Ltd., Bournville)

know more of this or any other aspect of chocolate manufacture should consult *Cocoa and Chocolate: Their Chemistry and Manufacture*, by R. Whymper. Good milk chocolate is an ideal food, each pound of a well-known British make containing roughly 1½ pints

of milk from which the water has been evaporated, 5 oz. of cacao bean products, and 7 oz. of sugar.

Now that the members of the medical profession are beginning to appreciate the fact that milk when reduced scientifically to the dry form retains many of its virtues and is free from bacterial dangers, the position of milk chocolate as one of the finest forms of confectionery for children is established.

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CHAPTER XIII

COMPOSITION AND FOOD VALUE OF COCOA AND CHOCOLATE

"Of all the foodstuffs offered by the vegetable kingdom directly to man, the cacao bean stands out as a phenomenon. In no other case has Nature crowded such a wealth of valuable nutritive elements into so small a space."—DR. ERICH HARNACK.

THE roasted cacao bean consists of husk (or shell), germ (or radicle), and nib. Although not the invariable practice, most cocoa and chocolate manufacturers separate the shell and the germ from the nib. The husk, as we have seen, has a comparatively low food value, and contains a relatively high percentage of crude fibre; the germ, although it contains a considerable amount of useful dietetic ingredients, is usually separated because it is hard and flinty and presents difficulty in grinding. The following are representative compositions of pure nib, shell, and germ—

ANALYSIS OF THE ROASTED ACCRA CACAO BEAN

	Nib (87·3%)	Shell (12%)	Germ (·7%)
Cacao Butter	55·75	3·76	2·96
Theobromine	1·42	1·44	2·14
Caffeine	·08	·05	·19
Protein	10·25	15·58	28·88
Cacao Starch	6·22	—	—
Mineral Salts	2·67	8·18	6·82
Crude Fibre	2·61	18·61	5·16
Moisture	1·44	3·75	6·47
Digestible Carbohydrates, etc. (by difference)	19·56	48·63	47·38
	100·00	100·00	100·00
Total Nitrogen%	2·08	2·95	5·31
Energy-giving power, Calories per lb.	3,024	1,354	1,535

The human body has been compared to a blacksmith's forge and our lungs to the bellows. The food we eat takes the place of the coal, and our lungs supply the blood with air (or rather oxygen) by the aid of which the fuel is burned. The burning (or oxidation) of the foodstuffs supplies energy, part of which appears in the form of heat to keep the body warm, and part of which is used up in the functions and activities of the body. Thus we can speak of the energy-giving power of a foodstuff. It is usual to express this as calories per lb., a calorie being the amount of heat required to raise 1 kilogramme of water 1° C. (or 1 lb. of water 4° F.).

Whilst most of the constituents of a foodstuff are of use to the human body, only the fats, carbohydrates, and protein supply heat or energy. As the cacao nib is rich in these constituents, it has a very high fuel value (3,024 calories per lb.) which is more than twice as great as that of meat or bread. Its high fuel value has long been recognized by the Admiralty. According to the *Daily News* the Naval Victualling Yard at Deptford issues in a year to the Navy 750,000 lb. of drinking chocolate. This is in block form and contains all the original butter in the cacao nib. Many people, certainly those who live sedentary lives, would find this drink too rich and buttery. For these the manufacturer provides cocoa, which it will be remembered consists simply of the cacao nib from which some of the butter has been expressed. In this way the manufacturer obtains a well-balanced foodstuff, which even those with delicate digestions can readily assimilate. J. Forster, who has studied the digestibility of cocoa powder, found (*Hygienische Rundschau*, 1900, p. 305) that the fatty and mineral constituents of cacao are both completely assimilated and the nitrogenous constituents are digested in the same proportion as in bread. The greater digestibility, the improved flavour,

and the greater ease of preparation are the chief causes of the popularity of cocoa powder.

Composition of Cocoa. In the table below will be found the figures obtained by Dr. R. H. A. Plimmer, and published in 1921 for the purpose of calculating the food values of foodstuffs used by His Majesty's Services. His figures are the mean analyses of six cocoas. For comparison, the average compositions of the two types of high-class cocoas of British manufacture are given—

ANALYTICAL DATA FOR COCOA

	Dr. Plimmer's Figures	Cocoa Essence	"Soluble" Cocoa
	Per cent	Per cent	Per cent
Cacao butter	26·8	28·0	28·0
Cacao starch	40·3	10·2	10·0
Other digestible carbohydrates		27·2	25·3
Protein	18·1	18·1	17·7
Crude fibre	3·7	4·2	4·2
Water	4·9	5·0	5·0
Mineral constituents	6·3	5·0	7·5
Theobromine	—	2·2	2·2
Caffeine	—	0·1	0·1
	100·1	100·0	100·0

Dr. Plimmer calculates the average energy value per lb. as 2,214·5 calories. As he assumes that the nitrogen all exists as protein his value is a little in excess of the true figure. The very high fuel value of cocoa will be best realized by comparing it with the following figures showing calories per lb.: cod fish, 209; potatoes, 302; eggs, 594; beef steak, 960; and bread, 1,180. Of tea, coffee, and cocoa, the three most popular household beverages, cocoa is the only one that can be considered a food. It is this fact that makes cocoa of particular value to those whose incomes are near the subsistence level. Viewed in this light, cocoa is a very

economical foodstuff. In considering the high food value it should always be remembered that in a pint of cocoa, only a small quantity of cocoa powder, about half an ounce, is usually taken. It should therefore only be regarded as an accessory food. Nevertheless,

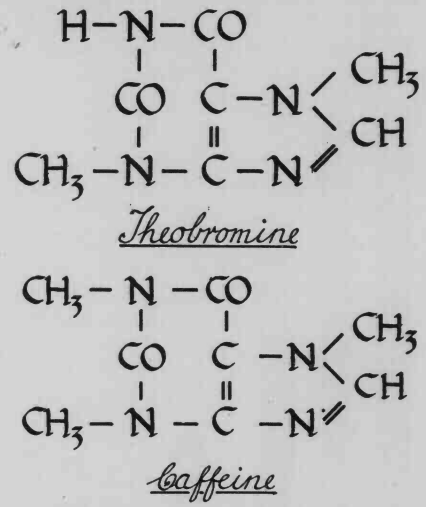

FIG. 39

The above chemical formulae of theobromine and caffeine show how closely they are related in composition and structure, with just that little difference which gives to each its peculiar physiological action

a pint of cocoa made with one-third milk, ½ oz. of cocoa, and 1 oz. of sugar has a fuel value of 320 calories, and is, therefore, equivalent in energy-giving power to a ¼ lb. of beef or four eggs.

Besides the flesh-forming and energy-supplying constituents, cocoa has other ingredients of dietetic value, namely, stimulants, mineral salts, and aromatic substances.

The most recent researches have shown that the

amount of stimulant present in cocoa as compared with tea or coffee is relatively high. The stimulating action is chiefly due to theobromine (2·2 per cent)

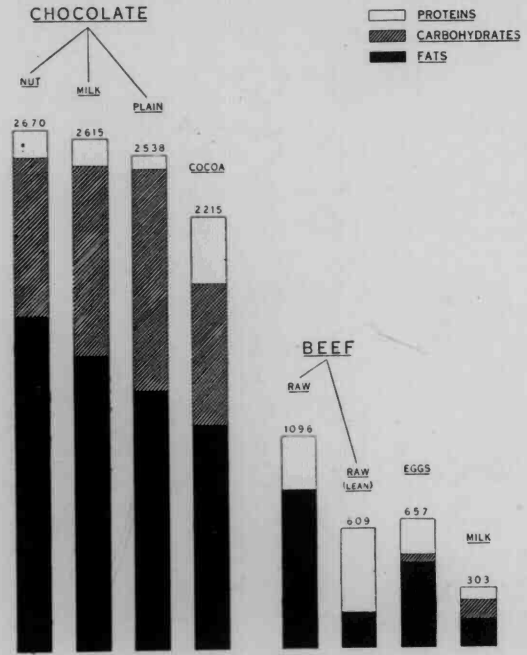

FIG. 40. DIAGRAM SHOWING FOOD VALUE OF COCOA AND CHOCOLATE

The columns show energy value of constituents in calories per lb.

(Reproduced by permission of the Cocoa, Chocolate, etc., Research Association, who exhibited this and other charts at the Confectionery Exhibition at Olympia, 1929)

which is peculiar to cocoa. There is also present a small amount (0·1 per cent) of caffeine which is the active principle present in tea and coffee.

Theobromine has much less effect on the central nervous system than caffeine, as a result the stimulating effect of cocoa is mild and nothing like so pronounced as that of coffee. On this account cocoa is highly suitable for the susceptible nervous system of the child, and has sometimes been recommended for the neurasthenic. It is also a good beverage for old people because, whilst it is a tonic for the heart, its effect in raising the blood pressure is small.

The mineral salts will be dealt with under chocolate. According to Professor Minet, the aroma which is developed during the roasting of the bean stimulates the appetite and adds its tonic effect to that of the theobromine. A frothy steaming-hot cup of cocoa is an excellent drink to take after manual work or after a strenuous game, like football; it maintains the heat of the body, it relieves fatigue, and gives a comfortable feeling of satisfaction and stability.

With regard to the relative merits of untreated and alkalized cocoas, experts are not in agreement as to which is the more valuable foodstuff, but the original prejudice against alkalized cocoas, which was still in evidence twenty or thirty years ago, has now disappeared.

The Food Value of Chocolate. The following may be taken as representative of the average composition of English eating chocolate sold by reputable makers—

COMPOSITION OF CHOCOLATE FOR EATING

Cacao butter	32·0
Protein	4·0
Cacao starch and other digestible carbohydrates	9·0
Tonic stimulants— Theobromine and Caffeine	0·5
Calcium and Potassium as Phosphates, and other salts	1·0
Crude fibre	1·0
Moisture	1·0
Sugar	51·5
	100·0

This chocolate has an energy value of over 2,500 calories a lb., which is higher than the value of the majority of our foodstuffs. Its high butter content and its attractive flavour have one disadvantage: chocolate, like that other excellent foodstuff, cream, is sometimes eaten in excess. Butter is known to be one of the most digestible of fats, and J. A. Gardner and F. W. Fox (*Biochemical Journal*, 1919) have shown that cacao butter is only slightly less digestible. In their researches they deliberately gave their subjects unusually large quantities of cacao butter, but, beyond a slight laxative action, no undesirable physiological effects were observed. It is now recognized that the digestion of the cacao butter is made easier by the presence of the sugar, and also to some extent by the spices or vanilla added as flavouring. Whilst some consumers regard chocolate merely as a luxury, the doctor who finds it impossible on his rounds to get a meal, the explorer, the camper, the climber, indeed all who have to carry an emergency ration, are well aware that this compact foodstuff has remarkable sustaining properties. Further, its effect is manifest almost immediately after consumption. This is partly due to the sugar present. The rapidity with which sugar is absorbed by the system and becomes available as an immediate source of energy is well known. Dr. T. L. Bolton, Head of the Department of Psychology, Temple University, Philadelphia, by a series of experiments in 1929 on twenty office girls, showed that the mid-afternoon lassitude is relieved and the efficiency increased by the consumption of small quantities of foods, such as confectionery, having a high sugar content.

When cocoa is completely burned about 5 per cent of mineral matter is left behind. This contains a remarkably high percentage of potassium, magnesium, and calcium phosphates. The phosphates are of obvious value, and the relatively high lime content of cocoa

and chocolate is now considered of importance dietetically. In 1929, Professor L. Neuberger reviewed the work of Dr. Friedrich Bosser who has cured heart weaknesses, neurasthenia, etc., by encouraging his patients in the indulgence in lime-containing foods. The most striking outcome of these investigations is that Professor Neuberger not only recommends cocoa and chocolate as a cure for heart troubles, but also for obesity! If we accept the importance of lime to the human body, then the arguments apply with even greater force to high-class milk chocolate, as this is exceptionally rich in lime salts.

CHAPTER XIV

ADULTERATION, STANDARDS, AND DEFINITIONS

Cocoa. We have to thank the public analysts that gross and frequent adulterations of cocoa are in Great Britain things of the past. It is due to their work that it is now generally recognized that if a substance is labelled cocoa it must consist of partially defatted cacao nibs ground to a powder. It may or may not contain small amounts of flavouring, or have been treated with alkaline salts, but it can contain no other substance; for example, no diluent such as sugar, arrowroot, or other form of starch can be present unless this is clearly stated on the package, and a definite declaration is made that the article is a mixture of cocoa and other ingredients. This result has been achieved not by legal definition, but by the legal actions which public health authorities have taken from time to time on the statements in public analysts' certificates. In 1928 as many as 1,129 samples of cocoa were examined, but only one was reported as being adulterated or not up to standard. The percentage of adulterated samples was as follows: in 1926, 0·2 per cent; in 1927, 0·4 per cent; in 1928, 0·1 per cent. Samples were reported against for containing sugar and arrowroot, and for being deficient in cacao butter.

There is one common cause of inferiority which appears to be ignored, and that is the presence of an excessive amount of cacao shell. In an important legal case some years before the war a cocoa containing 18 per cent of shell was found not to be adulterated on the principle that the whole bean, with the shell on, could be used to manufacture cocoa. This view was set aside in 1918 by a Cocoa Powder Order made by the Food Controller. This provided that " no cocoa powder may

be manufactured which contains more than 5 per cent of cacao bean shell." If it contained less than 2 per cent shell it could be called Grade A, and if less than 5 per cent (and at least 22·5 per cent cacao butter) Grade B. Incidentally, the maximum retail price of Grade A was fixed at 3s. 2d. a lb., and Grade B at 2s. 6d. a lb. This order was rescinded a few years after it was made. Owing to the natural variations in the composition of different varieties of cacao beans, it is doubtful if the known analytical methods are sufficiently delicate to determine accurately the presence of small percentages of shell. Hence, the safest course for the consumer is to purchase only cocoa made by firms of good repute.

Chocolate. There exists in England no legal definition of chocolate, and it is doubtful if the ordinary purchaser knows the exact nature of the substance he demands when he asks for chocolate. Whilst the majority may expect a mixture of cocoa and sugar, it seems probable that provided the sweetmeat is wholesome and has the flavour of chocolate, many consumers are satisfied. One reads in the past of brickdust, red ochre, and other objectionable substances being found in cocoa and chocolate, but the use of harmful ingredients as adulterants is very rare to-day. There have been few prosecutions in connection with chocolate. An interesting one occurred in 1908, when the vendor of a confection called " Finest Broken Swiss Milk Chocolate " was fined, the analyst having failed to find cacao nib or milk. The manufacturer explained that it contained $2\frac{1}{2}$ per cent of cacao nib and $2\frac{1}{2}$ per cent of separated milk powder. The brown colour was obtained by the use of finely-powdered cacao shell, and the defence was that as there was no definition of chocolate, one was justified in using the term for an article containing only small quantities of cocoa constituents It is cases of this kind that make one wish for definitions.

For many years there has been sold in England confectionery called chocolate which contains, besides sugar and a little cacao bean, certain cheap but harmless ingredients, such as coconut fat. No legal action has been taken against these cheap products. In certain Continental countries, where drinking chocolate is an important form of chocolate, a precise meaning is attached to the word, and definitions of cocoa and chocolate have been made by the respective governments, by associations of food chemists, and by associations of chocolate makers. Probably the first two countries to make a legal definition for chocolate were Belgium in 1894, and Roumania in 1895. Later came attempts at international definitions, the first of which was proposed by the White Cross Society of Geneva in 1908. In London, in 1909, N. P. Booth put forward a series of standards at the International Congress of Applied Chemistry, but in England neither the public themselves nor the public health or legal authorities appear to have shown interest in the question of the composition of chocolate. In 1911 an attempt was made by European manufacturers to agree amongst themselves upon certain standards, and at the International Congress of Manufacturers of Cocoa and Chocolate at Berne a series of definitions was considered. Those adopted—and pigeon-holed—are given in full at the end of this chapter. A representative from England, speaking for twenty British manufacturers, did not accept these standards, and would not agree to recognize any resolution which the conference passed as in any way binding on British industry. Everyone will agree that the insistence on accurate labelling makes for standard products, and defends the manufacturers of pure and unadulterated foodstuffs from the competition of cheap and inferior substitutes. At the same time, it must be admitted that too precise definitions hamper the art of the confectioner, and prevent him

using wholesome and expensive ingredients which would improve the confection in flavour or in other ways. It is difficult to frame definitions which prevent adulteration and at the same time do not prevent improvement. The confectioner does not always wish to declare his additions, as this would reveal his recipe to his competitors. It will be interesting to see what will be the outcome of the re-examination of the definitions at the second International Congress of Cocoa and Chocolate Manufacturers, which is being held in Antwerp in 1930.

DEFINITIONS ADOPTED AT THE INTERNATIONAL CONGRESS OF CHOCOLATE AND COCOA MANUFACTURERS, *BERNE*, 1911

1. Cacao Mass

1. Cacao mass is obtained by roasting or drying cacao beans which have previously been well cleaned and freed from the shells and dust. Cacao mass can either be disintegrated, i.e. "soluble" or untreated with disintegrating agents, i.e. "insoluble."

Cacao which has been treated according to (5) is in the real and business sense of the term to be regarded as a pure article of food, seeing that the treatment with alkaline carbonates or pure alkali is a purely chemical, or technical, operation. Such cacao may, therefore, be justly termed "pure."

2. Cacao mass may contain a quantity of added cacao butter proportionate to the prescribed, or suitable, fat content of the cacao preparation to be made.

2. Cocoa Powder

3. Cocoa powder should consist of defatted, or fatty, pulverized cacao mass.

4. Cocoa powder which has been opened up by means of alkalis or otherwise, is termed "soluble" or disintegrated cocoa.

Disintegrated cocoa which has been treated as described under (5) may in the real and business sense of the word be regarded as a "pure" article of food, as the treatment with alkaline carbonates or pure alkalis is a purely chemical, or technical, operation. Such cocoa may, therefore, be justly termed "pure."

5. The quantity of alkali used to effect the treatment described should not exceed 5·75 grammes of potash or the equivalent of another alkaline carbonate, to 100 grammes of dry defatted cacao.

3. Cacao Butter

6. Cacao butter consists of the fat obtained from either untreated or disintegrated cacao.

4. Chocolate and Chocolate Powder

7. Chocolate is a mixture of cacao mass and sugar, with or without the addition of cacao butter. On pulverising chocolate, chocolate powder is obtained.

8. Both chocolate and chocolate powder may, if the methods of manufacture require it, be prepared from partially defatted cacao mass.

9. The amount of cacao mass and cacao butter contained in chocolates and chocolate powders should be at least 32 per cent of the whole.

5. Milk Chocolate

10. Milk chocolate should consist of a mixture of cacao mass, cacao butter, sugar, and milk or milk powder. The quantity of cacao mass and cacao butter contained in such preparations should amount together to at least 25 per cent of the whole.

11. All chocolates which are brought on to the market under the name of milk chocolate must contain at least 12·5 per cent of milk or milk powder.

12. No milk used for the preparation of milk chocolate may contain any preserving agent.

6. Covering Chocolate

13. The definitions of chocolate proper apply also to covering material.

14. Covering chocolates may, without special designation, contain up to 5 per cent of its weight as sold of almonds, nuts, milk or milk powder. All other additions must be clearly declared on the packages in which the covering material is sold, or in the invoices referring to it.

7. Flavouring Matter (Spices)

15. All material (spices, etc.) used for flavouring cacao preparations must be harmless.

CHAPTER XV

THE STORAGE OF CHOCOLATE AND COCOA, AND PREVENTION OF SPOILAGE[1]

A CHAPTER FOR SHOPKEEPERS

As chocolate presents the greater number of storage problems, it is proposed to deal with this in some detail. At the outset it may be mentioned that the manufacturers have not yet found a reasonably priced package or container which is proof against bad storage conditions or the vagaries of the weather. Every year hundreds of pounds of chocolate or chocolate goods are spoiled by imperfect storage in shops or stores. The loss of goods is considerable, and the loss of custom to those who unwittingly sell badly-stored goods must be even more serious. The reader may be interested to note what precautions the properties of chocolate necessitate if these losses are to be prevented.

Plain chocolate or chocolate assortments, stored under the correct conditions, will keep in good condition longer than most foodstuffs. Nevertheless, the best chocolate in the world will gradually go stale. Under perfect conditions, plain chocolate will keep fairly well for a year; under good shop conditions, for about six months; but, under unsuitable conditions, it can be spoiled in a few minutes. Chocolate assortments have not such good keeping properties as plain chocolate, as they contain materials which are more sensitive to adverse conditions than chocolate itself.

Odours. Chocolate readily takes up odours. Thus, chocolates which have been stored in a room where there is a small escape of gas will taste unpleasantly

[1] Most of the material in this chapter is taken by permission of Messrs. Cadbury Bros., Ltd., from an article by the writer which appeared in *Bournville*, 1928.

gassy. Ladies sometimes utterly spoil the taste of the contents of a gift box of chocolates by putting it in a clothes drawer which contains moth balls (" carbon " or naphthalene). The odour of fish, of scented soap, of cheese, of fire-lighters, of tobacco—indeed the odour of any strongly smelling substance—is readily taken up by chocolate, and hence, if its own delightful odour and flavour are to be retained, it must never be stored near strongly smelling goods.

Heat and Light. The dangers arising from heat and sunlight are very great, because chocolate is a rich fatty food, containing a large quantity of cacao butter. If chocolate is held in the hand the cacao butter softens and the chocolate becomes almost liquid. The direct rays of the sun are warmer than the hand, and if they shine on chocolate the cacao butter melts and partially separates, so that when the chocolate cools its appearance is quite spoiled. Exposure to heat from a fire, stove, or gas jet will produce the same effect.

In those shops where the sun can shine directly on to the stock, whether in open or closed boxes, blinds are essential and have to be kept down whenever the sun shines. Apart from spoiling the chocolates in the boxes, the sunlight bleaches the bright colours of the labels and gives the stock a stale appearance.

The question arises as to what is the ideal temperature for a chocolate shop or store. Only the most advanced shopkeepers have thermometers, which they hang alongside the stock. It is found that the ideal temperature range is 55° F. to 65° F. It is difficult to keep always within this range, but it is known that wide fluctuation should be avoided, and preferably the temperature should not rise above 70° F. The shop or store is kept as cool as possible in warm weather, for when the air in the shop gets hot and stuffy (75° F. to 80° F.) a curious white " bloom," like the bloom on a plum, may appear on the surface of the chocolates.

Whilst this does not in any way affect the flavour or wholesomeness of the chocolate, it spoils the appearance, so that the shopkeeper does not care to sell, or the customer to buy, such chocolates.

During very hot weather the ventilation of the store has to be carefully controlled. During the daytime, when the outside air is warmer than the inside, as little air as possible is admitted; but several hours after sundown, when the outside air is the cooler, ample ventilation can be allowed with advantage.

The top storey of a building is generally unsuitable for chocolate storage, as the roof is liable to get very hot and also to suffer violent fluctuations in temperature. The basement is generally too damp. It has been found that the middle floor is the most suitable one for chocolate storage.

The Action of Damp. Every one knows that the air always contains invisible water. On certain days there is so much invisible water in the air that some of it is deposited on the salt in the salt-cellar, and we comment on the wetness of the salt. The warmer the air, the more invisible water it is likely to contain. Thus, if a tumbler of cold water is brought into a warm room, the surface of the glass becomes dimmed. The explanation of this is that the invisible water in the air is cooled, and minute drops of water are deposited from the air as dew on the glass. In shop windows one sometimes sees the exposed chocolate covered with tiny drops of water. Chocolate contains no moisture: this water has not sweated out of the chocolate—it has been deposited from the air as dew. Whether this water dries up or not, the appearance of the chocolate is quite spoiled.

It should be carefully noted that damp air has remarkable penetrative powers, and can penetrate cardboard, or even wooden, boxes and spoil the contents.

The shopkeeper has to take considerable care if he

is to keep the air in his shop dry. In the summer he relies chiefly on ventilation; and in the winter on heat. Obviously, in wet, misty, or foggy weather, as little as possible of the outside air is allowed to enter. The draught which blows through the open door on warm, wet days is likely to spoil any goods on which it blows directly, and, therefore, as far as possible, the stock is shielded from warm westerly breezes.

During the winter the shop can be kept dry by keeping it definitely warmer than the air outside. A temperature about 10° F. above the temperature of the outside air is desirable. The heating is most effectively done with radiators placed against the walls, and only a little heat is needed.[1]

Walls are always liable to be damp, and the thoughtful shopkeeper makes some arrangement which renders it impossible to push the boxes into contact with the wall. One device is to have narrow strips of wood nailed at intervals upright against the wall. It is very difficult to store chocolate in new buildings, as these are always damp for at least a year, and special precautions have to be taken.

The Window Display. Shopkeepers recognize the stimulating effect of an attractive window display, but the wise confectioner knows that the window is the last place to *store* chocolate, and hence he uses dummy boxes wherever possible, and changes the goods in the window once a week or at least once a fortnight. Chocolates displayed in the window are placed at least 6 in. from the window-pane, as they are then less likely to become covered with dewdrops.

At night, and during week-ends, the inside window blinds are drawn so that the cool, damp air next the window will fall between the window and the blind.

[1] Electric heaters are ideal; anthracite stoves are good; gas stoves with flues are satisfactory if the waste gases are not allowed to enter the room. Gas jets are objectionable.

Drawing the blinds also has the advantage of preventing the severe cooling of the shop which occurs during the night.

Electric light is obviously preferable to gas, as gas in burning produces large quantities of water.

Should an exposed layer of goods become dusty, the dust is sometimes removed, and the appearance much improved, by lightly brushing with a camel-hair brush.

The Secret of Good Storage. Spoilage occurs most in those boxes which have been overlooked and have lain stagnant. The secret of good storage is to use all stock in strictest routine, always selling the oldest first. A confectioner once called the writer's attention to the simple and efficient method by which he ensured this. When a consignment arrives, he places all the boxes on the counter, and if he gave his previous consignment the number 56, he plainly marks all the new consignment 57. So that at any time a glance at his shelves tells him immediately which is his oldest stock.

We are now in a position to draw up the rules which, if followed, will result in satisfactory storage of chocolate—

1. Chocolate or chocolate assortments should never be placed alongside strong-smelling goods.

2. The sun must never be allowed to shine on chocolate or chocolate goods (or boxes or packets containing chocolate).

3 The temperature of the shop or store should be even and cool. Avoid storing near or above a fire, stove, radiator, or gas jet.

4. Store in a dry place.

5. Never store chocolates less than 1 ft. from the floor, or less than 3 ft. from the ceiling.

6. All windows in shop or store should be provided with blinds.

7. No box of chocolate should touch the wall, as walls are liable to be damp.

8. No chocolate goods should be displayed close against the window.

9. Use stocks in strict routine, according to age.

Whilst the above rules may usefully be applied to loose cocoa powder in barrels or to heaps in a grocer's window, the storage of cocoa, as almost universally packed, in *tins* does not call for so many precautions as chocolate. Cocoa, however packed, gradually loses its freshness on keeping, and it is essential that the temperature of the shop or store should not rise above 85° F., or the cacao butter will melt, the cocoa clog, and the appearance be spoiled.

CHAPTER XVI

STATISTICS OF PRODUCTION, CONSUMPTION AND MANUFACTURE

THE figures showing cacao production in the table below are compiled from the *Gordian*, the most reliable source of cacao statistics—

WORLD'S HARVEST OF CACAO BEANS
(In tons of 1,000 kilos)

Producing Country	1902	1912	1922	1927[1]
	Tons	Tons	Tons	Tons
Gold Coast (B)	2,710	39,260	158,771	208,349
Brazil	20,642	31,415	45,279	75,543
Nigeria (B)	200	3,463	31,754	36,967
San Domingo and Haiti	10,965	23,876	21,485	28,444
Ecuador	24,398	37,078	43,396	23,600
Trinidad (B)	17,612	18,878	22,874	23,557
Venezuela	9,925	10,985	18,700	15,400
San Thomé	17,619	36,012	18,577	14,432
French Colonies	925	1,706	9,000	11,109
Spanish Colonies (Fernando Po, etc.)	1,198	2,229	4,536	6,600
Grenada (B)	6,043	5,519	3,703	5,104
Costa Rica	—	309	3,289	4,800
Ceylon (B)	2,673	3,720	4,257	4,007
Jamaica (B)	—	3,374	3,915	2,982
Java, etc.	889	2,024	1,092	1,105
Surinam	2,355	962	1,533	209
All others	5,326	11,247	8,222	24,897
TOTAL	123,480	232,057	400,383	487,105

(B) denotes British Empire.

From a study of the above figures showing the world's production of the raw material of the industry, one realizes that the cultivation of cacao has not been neglected. Looking back over the last twenty-five

[1] Estimated.

years one notes the continuous increase in cacao production, and that during this period the world's harvest has grown to four times what it was in 1902. This is largely due to the Gold Coast, but Brazil, Nigeria, and San Domingo have made great increases in their contributions. The poet has spoken somewhere of mournful numbers—those concerning the Gold Coast cacao crop make cheerful reading, and the history of Accra cacao may be epitomized thus—

GOLD COAST CACAO PRODUCTION

Year	Tons of Cacao	Value
		£
1892	0·1	4
1902	540·0	27,280
1912	38,624·0	1,642,733
1922	156,271·0	5,753,478
1927	205,068·0	11,727,566

Briefly noting the other producing centres in order of quantity, one observes that Brazil, having by 1917 overtaken Ecuador for second place, has forged ahead and soundly established its position as the second largest producer in the world. This remarkable increase in the output of Brazil is due mainly to the State of Bahia, the average of whose output for the years 1922–27 was about 1,000,000 bags, or roughly 59,000 tons, the major part being supplied from the Ilheos district. In 1925–27 Brazil produced 14 per cent of the world's output. The cacao is one of the common sorts, but experiments in the planting of Criollo are being made.

Ecuador, once the second largest producer, owing chiefly to the witch-broom disease had sunk by 1927 to the fifth place. It is famous for its Arriba cacao, a fine characteristic cacao, which is not too well prepared for the market. Ecuador contains several very large

estates, the greatest being the Caamano Tengel estate on which grow 2,500,000 cacao trees.

Nigeria has made great strides forward in output and quality in the last ten years and now takes third place, having advanced in quantity in front of Ecuador, San Thomé, and Trinidad. In 1927 its cacao exports

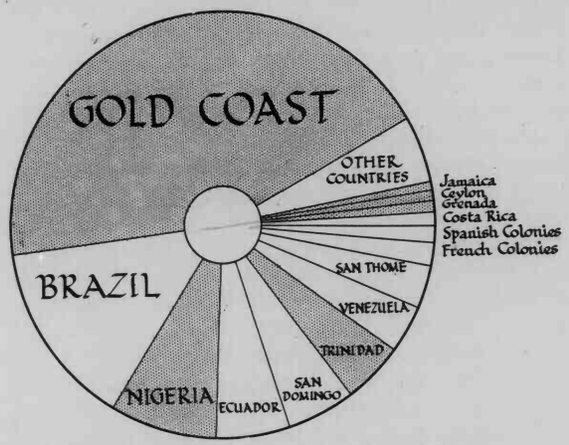

FIG. 41. CACAO PRODUCTION OF THE WORLD

The mean World production for 3 years, 1925–27, was 487,000 tons per annum.

This diagram shows the relative amounts of beans produced by the chief producing areas during 1925–27. The shaded parts show production in the British Empire

were about 8 per cent of the world's output, and had a value of £1,968,612. In 1928 it exported 49,209 tons, and for 1929 the estimated figure is 52,000 tons. Not only is the output increasing, but there are definite signs that its somewhat poor quality is improving: more care is being taken in its preparation for the market, and it is being carefully inspected and classified at the port.

The Dominican Republic (Santo Domingo) is rising in importance. In 1925–27 it produced over 5 per cent

of the world's output. A large portion of the Sanchez and Samana cacaos goes to the United States. They are common kinds, and on the New York market fetch about the same price as Accra cacao. In 1928 the President of the Dominican Republic signed a decree making fermentation compulsory.

Trinidad's production approaches 5 per cent of the world's output, and is the third largest in our Empire. Trinidad has long been known for its fine and well-prepared cacao, and is responsible for a large share of our present knowledge of cacao cultivation. The adjacent isle of Grenada produces 1 per cent of the world's output. The cacao beans are small, but the constancy of its quality has given Grenada cacao a definite standing on the market.

Venezuela produces nearly 4 per cent of the world's harvest. Its importance lies in the high quality of much of the cacao grown there, its Caracas cacao being probably the finest in the world.

San Thomé now only produces some 3 per cent of the world's cacao. The plantations have suffered from an insect pest (Thrips), and the output has decreased in the last ten years. San Thomé possesses some of the largest and most highly-organized estates in the world, the famous Agua Isé estate having produced some 4,000 tons of cacao per annum.

Ceylon cacao has a very beautiful external appearance, and the fine varieties have the pale interior characteristic of pure Criollo.

The export of cacao from Costa Rica has risen sufficiently in the last ten years to deserve special mention. It now contributes 1 per cent of the world's crop.

The Ivory Coast has now begun to export in quantity, and its future production will be watched with interest.

The sudden drop, almost to extinction, of the cacao exports from Surinam is due to the drought of 1926.

Consumption. The mean total production for the three years 1925–27 was 487,000 tons per annum, and the mean consumption over 475,000 tons.

The figures given below are compiled from the *Gordian*. They show the amount of cacao beans used by the industry in the various countries, and illustrate the changes in consumption which have occurred in the last twenty-five years. The same years are chosen as for production so that they may be directly compared—

WORLD'S CONSUMPTION OF CACAO BEANS
(In tons of 1,000 kilos)

Consuming Country	1902	1912	1922	1927[1]
	Tons	Tons	Tons	Tons
U.S.A.	23,120	66,553	150,701	187,594
Germany	20,687	55,085	84,006	70,238
Great Britain	20,386	28,044	51,341	56,741
Holland	9,172	24,921	36,137	39,750
France	19,343	26,891	38,568	28,046
Spain	6,002	5,250	8,496	8,000
Canada	312	3,039	7,757	7,667
Switzerland	5,707	10,342	2,986	7,538
Austria	1,820	7,734	2,644	6,737
Czecho Slovakia	—	—	3,837	6,625
Italy	466	2,432	4,813	6,462
Belgium	2,277	6,992	9,232	5,478
Australia	554	747	8,000	5,000
Sweden	591	1,449	3,417	3,378
Norway	410	1,136	2,222	2,116
Denmark	826	1,727	1,844	2,214
All others	2,480	9,147	5,808	24,221
TOTAL	114,153	251,589	421,809	467,805

The United States in 1925–27 consumed over one-third (38 per cent) of the world's cacao consumption. It is said that, when the States "went dry," many of the breweries were converted into chocolate factories. This may partly account for America's amazing appetite for cacao products. To satisfy this appetite, New York imports every year from two to three million

[1] Estimated.

bags of cacao. Of these, about half come from the Gold Coast, although in pre-war days Accra cacao was practically unknown in the United States. Thus, in 1929, out of a total of 3,247,650 bags sold for consumption in U.S.A., 1,623,218 were Accra and 674,685 were Bahia cacao. The consumption of cacao per head has

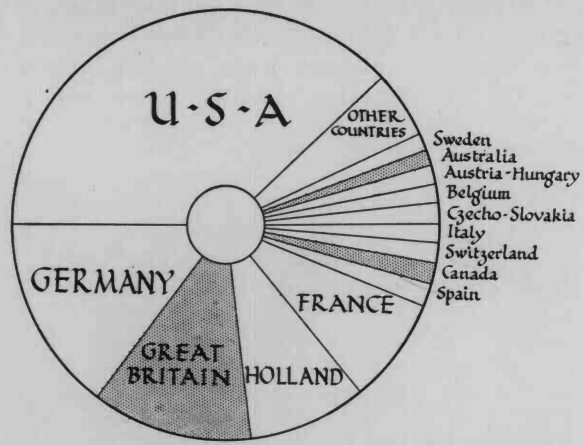

FIG. 42. CONSUMPTION OF CACAO BEANS

The mean World consumption for 3 years, 1925–7, was 475,000 tons per annum. This diagram shows the relative amounts consumed by the chief consuming countries during 1925–7

shown a rapid increase—in 1916 it was 1·6 lb. for each person, and in 1920 was 3·2 lb.

Germany lost her position of second largest consumer during the war, but has decisively taken that position again since 1921, and now imports on the average about 15 per cent of the world's total consumption.

Great Britain. Although 60 per cent of the world's cacao is grown within the British Empire, Great Britain only consumes about 12 per cent of the total production. At the same time, as will be seen by reference to the table (page 27) in the chapter on History,

there has been a very steady rise in the amount of cacao consumed in the last hundred years. For example, in 1926 and 1927, Britain consumed about double the amount taken in 1912 and 1913. The consumption per head, however, does not approach the American figure given above: from 2·0 lb. per head in 1915, it rose to 2·4 lb. in 1920, and this figure has just about been maintained. The home consumption in recent years is given in English tons in the table below, which is taken from the Board of Trade Returns—

CACAO IN THE UNITED KINGDOM

Year	Imported	Exported	Home Consumption
	Tons	Tons	Tons
1925	67,298	12,915	56,305
1926	59,461	9,313	56,409
1927	64,057	4,490	55,843
1928	63,330	7,224	55,566
1929	77,409	10,685	57,497

Stocks. The total stock of raw cacao in the world (apart from that in manufacturers' stores), taken on the last day of the year, used to amount to round about 40 per cent of the year's harvest or consumption. It has recently fallen to about 16 per cent. The stock held in England at the end of 1927 was 21,285 tons; 1928, 21,600 tons; 1929, 31,750 tons.

The cacao imported into the United Kingdom came from various producing centres, as given on page 176.

In pre-war days about 50 per cent of the cacao imported into the United Kingdom was grown in British Possessions. By 1919 this had increased to 75 per cent. In that year a preferential duty was introduced, and, partly as a result of this, over 90 per cent of the cacao imported into the United Kingdom is now Empire-produced.

CACAO BEANS IMPORTED INTO THE UNITED KINGDOM

	1922	1927	
	Tons	Tons	Value £
British West Africa	50,930	54,403	3,499,012
British West Indies	6,692	4,515	356,353
Ceylon	1,130	768	69,548
Ecuador	1,365	1,592	149,687
Brazil	701	531	40,010
Venezuela	3,266	1,166	118,293
Other countries		1,083	88,375
Total imported	64,084	64,058	
Total value	£2,931,675		£4,321,278

Duty on Cacao. The duty, at the time of writing, on raw cacao beans is 1½d. per lb. on foreign, and 1¼d. per lb. on British. It may be of interest to tabulate the changes in the duty over the last seventy-six years—

DUTY PER CWT.
ON CACAO BEANS, CACAO BUTTER, AND CACAO SHELL
(1853–1929)

Year	On Cacao Beans and Cacao Butter		On Cacao Shell	
	British Per cwt.	Foreign Per cwt.	British Per cwt.	Foreign Per cwt.
	s. d.	s. d.	s. d.	s. d.
1853–1915	9 4	9 4	2 0	2 0
1915	14 0	14 0	3 0	3 0
1916 (April-June)	56 0	56 0	12 0	12 0
1916–1919	42 0	42 0	6 0	6 0
1919–1922	35 0	42 0	5 0	6 0
1922–1924	23 4	28 0	3 4	4 0
1924–1929	11 8	14 0	1 8	2 0

Statistics of Cocoa and Chocolate Manufacture. The figures below are taken from the latest census of production issued by the Board of Trade. In 1924 the number of people employed in the cocoa, chocolate, sugar confectionery, and jam trades was as follows—

Ages	Males	Females	Total
Under 18 years	2,836	20,051	22,887
Over 18 years	23,402	33,207	56,609
Total	26,238	53,258	79,496

It will be noted that about twice as many girls and women were employed as boys and men.

The consumption of cacao beans advanced from 1924 to 1928 by about 10 per cent; on the other hand, improvements have been made in manufacture and fewer workers are required for the same output, so that the total number of persons employed has probably not materially increased, and is still round about eighty thousand. The number recorded as management, clerical, and technical staff in 1924 was 11,038, and the operatives as 68,458. The goods manufactured by these from raw materials costing £24,092,000 had a value of £41,225,000. Of these manufactured products, about half the value was cocoa, chocolate, and chocolate confectionery, as shown by returns on page 178.

Roughly one-tenth of all cocoa and chocolate manufactured for sale was exported. The figures below show the net imports into, and the exports from, the United Kingdom for 1924—

	Exports		Net Imports	
	Cwt.	£	Cwt.	£
Cocoa or chocolate, manufactured	100,500	509,000	137,700	1,282,000
Chocolate confectionery	57,900	647,000	21,300	207,000
Sugar confectionery, except chocolate confectionery	206,300	1,186,000	71,300	379,000

QUANTITY AND VALUE OF COCOA AND CHOCOLATE, ETC., MANUFACTURED IN GREAT BRITAIN IN 1924

Products	Quantity Cwts.	Selling Value £
Cocoa Manufacture—		
Cocoa or chocolate, manufactured (except chocolate confectionery)	984,900	7,793,000
Chocolate confectionery . .	1,467,200	12,559,000
Cacao husks and shells . .	92,200	22,000
Cacao butter	77,600	487,000
Total	2,621,900	£20,861,000
Sugar confectionery (except chocolate confectionery) . . .	3,662,600	16,691,000
Cocoa products and sugar confectionery, not separately distinguished	—	309,000
Sugar confectionery and chocolate confectionery manufactured by bread and biscuit trades . .	221,000	1,947,000

The net imports consisted chiefly of sweetened chocolate in bars and blocks, obtained from Switzerland.

Our export trade of chocolate and sugar confectionery has recently shown little change. In 1925, 1926, and 1927 quantities were 268,000 cwt., 266,000 cwt., 279,000 cwt., and the values £1,925,000, £1,915,000, and £1,906,000.

As will be seen above, the totals of the imports and exports of manufactured cocoa and chocolate and chocolate confectionery are not very different, so that in 1924, when the population of Great Britain approached 47½ millions, the consumption of raw cacao was about 2¼ lb. a head, or the consumption of manufactured cocoa, chocolate, and chocolate confectionery was about 5¾ lb. a head per annum.

ENVOI.

Industry is being more and more considered as an organic whole, the life of which depends on the healthy growth of every part. The industry considered in this book has all the signs of vitality. On the scientific side the facilities for the study of cacao cultivation are being slowly but continuously improved —an important step in this direction being the opening of the West Indian Agricultural College, now the Imperial College of Tropical Agriculture, in Trinidad in 1922—and the annual output of research on matters related to cocoa and chocolate manufacture is being greatly increased by the Research Association founded in 1918. On the purely industrial side there are similar signs of healthy progress. On the one hand, we have the rapid increase in the production of the raw material, an increase which will continue unless Nigeria, Bahia, and the Gold Coast suffer a set-back. On the other hand, we have the enterprise of the manufacturers who, aided by the charms and virtues of cacao products, and in spite of high duties, have made consumption keep pace with production. In 1928 the Manufacturing Confectioners' Alliance decided to hold an exhibition at Olympia, London, devoted solely to chocolate and confectionery. This was so successful that it is now an annual event, and in 1929 over forty British manufacturers of chocolate or chocolate goods were represented, including many whose names are household words, e.g. Cadbury, Carson, Clifton, Fry, Kunzle, Meltis, Needler, Packer, Pascall, Rowntree, Terry, and others. The author hopes this little book has enabled the reader to take a comprehensive glance at the whole industry, and that it will incite him to study the current literature and larger works dealing with its various branches.

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Names of places are in heavy type.
An asterisk indicates an illustration.

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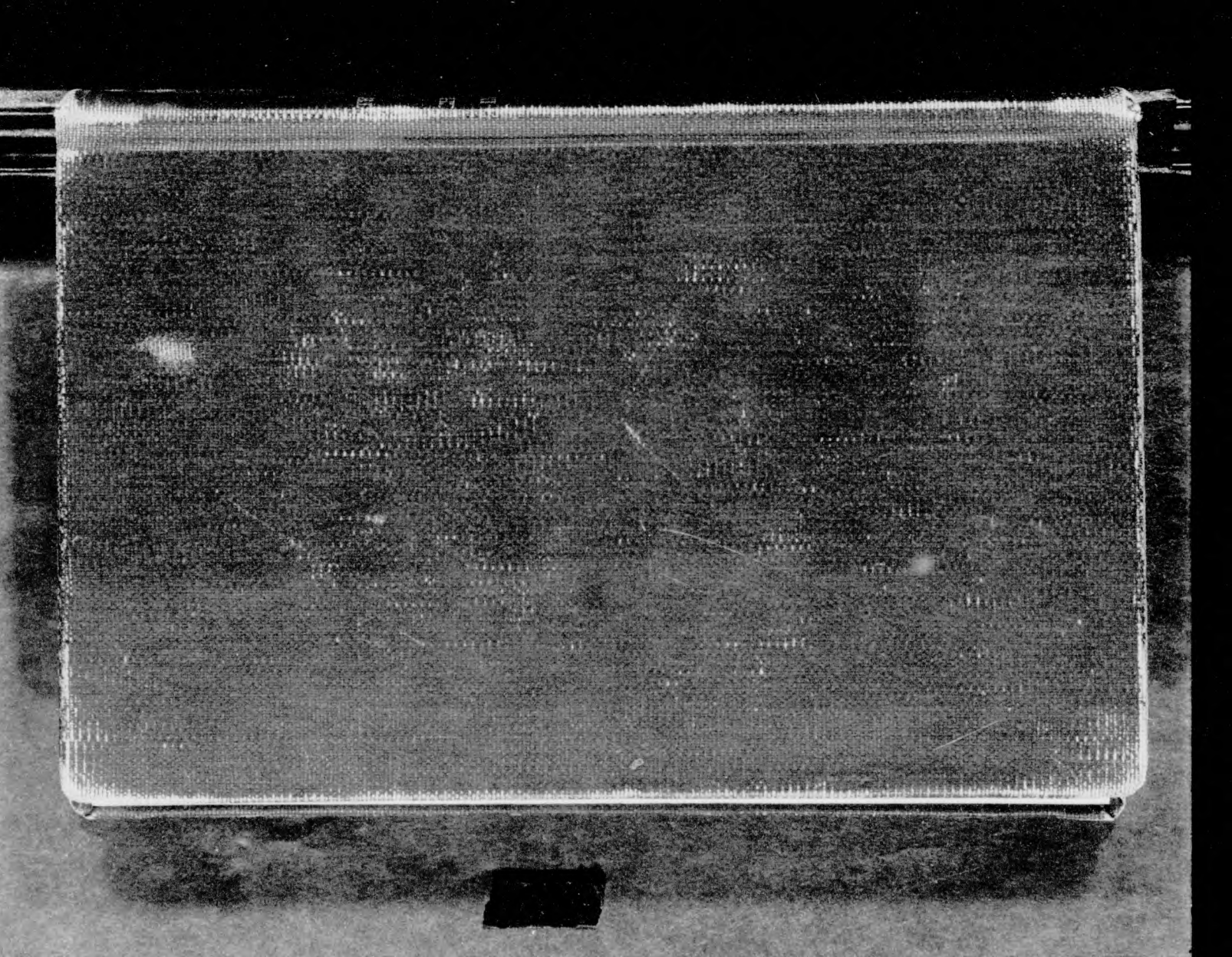

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